THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 56 — Thursday, June 17, 1937 — No. 1087

PUBLISHED WEEKLY

Subscription Terms : 15s. per annum.
Foreign and Colonial : 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, the Advertisement Manager, or the Publisher of

THE FOUNDRY TRADE JOURNAL
49, WELLINGTON STREET, LONDON, W.C.2

Telegraphic Address : "Zacatecas, Rand, London."
Telephone : Temple Bar 3951 (5 lines).

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF

The Institute of British Foundrymen

The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

and

The Foundry Trades' Equipment and Supplies Association

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Contents

	PAGE
The Derby Conference...	477
Official and Otherwise	477
Correspondence	478
Random Shots	478
Conference Visits to Famous Foundries in the Derby District :—	
Bamfords, Limited, Uttoxeter	479
Ley's Malleable Castings Company, Limited, Derby	480
Herbert Morris, Limited, Loughborough ...	483
Qualcast, Limited, Derby	485
Stanton Ironworks, Limited	486
The Loughborough College	490
American Notes	490
Statistics of the British Iron and Steel Industry ...	490
Institute of British Foundrymen : Thirty-fourth Annual Conference	491
Annual General Meeting	491
Opening of Conference	497
Presidential Address	499
Annual Banquet	502
Social	504
Excursion	504
The Third Edward Williams Lecture : Physical Factors in the Casting of Metals	505
The Problem of the Elimination of Gaseous Impurities in Aluminium	509
Recommendations Concerning the Establishment of Costs in a Grey-Iron Foundry	511
Use of Nickel in Non-ferrous Alloy Castings ...	513
The Week's News in Brief	518
Trade Talk	518
Personal	518
Obituary	518
Forthcoming Event	518
Raw Material Markets	520

The Derby Conference

One of the most successful of the thirty-four conferences held by the Institute of British Foundrymen concluded its deliberations last week. Mr. C. W. Bigg, the new President, has already infused a new enthusiasm, based on an assumption that the Institute cannot afford to rest on its laurels. It has effected profound changes in the outlook of the industry; it has created nationally recognised means for research and technical education in all its branches, but withal its major activities have failed to have beneficial repercussions on an important residue. As a realist, Mr. Bigg believes that if the industry as a whole did but two things—became cost conscious and surrounded itself with a better type of recruit—the situation would in a few years' time be ameliorated and general progress would be registered.

From no matter what aspect the Derby conference be viewed, it was an unqualified success. The Papers were excellent, the social arrangements ideal, and the works visits a flat contradiction to any notion of the backwardness of the foundry industry. It was pleasing to note the attendance of so many overseas visitors, and Australia was particularly well represented. Slight indisposition, unfortunately, prevented the attendance of Mr. A. H. Moore, of South Africa, but the premier Dominion was represented for the first time by that distinguished metallurgist, Mr. O. W. Ellis.

A feature of the Conference was the announcement of a munificent gift of £500 by the directors of Qualcast, Limited, to form the nucleus of a research fund. There are so many angles to research that this fund, wisely administered, can be utilised to strengthen the bonds with existing research organisations, by indicating that interest is not limited to mere lip service. We hope that this action will be emulated by the various employers' federations and foundry groups, as an annual revenue of £500 for the Institute earmarked for research would enable the technical committee to function on a new and better basis. Finally, may we congratulate the municipal authorities, the new President, the directors of the works which so kindly entertained the members, the subscribers to the hospitality fund, and especially Mr. Gale and his colleagues, on the undoubted success of their efforts to make the 1937 conference a memorable one.

Official and Otherwise

The list of Papers and visits for the Paris Congress which appeared in our last issue will have been read with interest, and the Papers appear in two divisions, official Papers and individual communications. We do not recall having seen this division on previous occasions. All such congresses now have exchange Papers from foreign official bodies, but, in general, Papers apart from these have been regarded as individual communications. For the Paris Congress there are ten official Papers, seven exchange Papers and three French Papers, two of the last-mentioned being each in two parts. There are thirty-four individual communications, mostly of course from French authors, but at least half a dozen appear to come from outside France. We are a little uncertain whether the grouping of Papers in the official class is intended to emphasise their importance or whether they may be regarded as having the approval and authority of the Association Technique de Fonderie, in which case they will have been read and approved in advance. The exchange Papers may of course be regarded as representative and approved by, because they are offered by, their respective originating bodies. Whether it is wise to describe as official other Papers is open to argument. In England Papers and reports originated by committees of a technical body may be considered as official in the sense that they are sponsored by the body concerned.

Incidentally, it may be added that the Papers and visits constitute for most prospective visitors to a congress the main attraction, and it is on them that most thought should be spent. The firms who have to consider the expense of sending a representative will be most inclined to decide favourably if the Papers and visits are attractive. The tendency to offer other attractions in the form of post-congress tours, mainly of social value, is useful to those who can spend their summer vacation in this way, but should not be allowed to mask the primary object of the congress itself, the discussion of Papers and the holding of visits in or near the chosen centre.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Recruitment Problem

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I have read with interest the letter published in THE FOUNDRY TRADE JOURNAL of May 27, signed "Qualified." This letter reminds one of the learned professor who was drowning. He had studied all the different ologies except "swimology"—the one which would have saved his life.

"Qualified" is suffering from a misapprehension in thinking that he is the type of man the foundry industry requires. The fact of his being unable to get a job proves conclusively that works executives know what they want.

Speaking as a foundryman with thirty years experience in a number of different foundries, I would like to point out a few "home truths" which may be of benefit to him. Firstly, it is a foundryman's job to run a foundry, and he must be a man who has learnt his trade and held a job as a journeyman, during which time he has studied the technical side of the trade to fit him to fill a supervising job, climbing the ladder to a higher executive position by passing through the hard school of experience.

There is no short "cuff and collar" way. Foundry work cannot be learnt from books, and one might go further and say that it cannot be learnt in five or six years' apprenticeship. Neither is it 75 per cent. metallurgy and 25 per cent. moulding practice; the figure would be nearer the truth if reversed.

Modern youth wants to start where experienced men leave off, and this cannot be done. One can visualise "Qualified's" age—we have all passed through this stage when we thought we knew everything there was to be known. Some of us who are older realise now how little we know and how much there is to learn. When "Qualified" has had a few more years of foundry experience he will not sign himself "Qualified."—Yours, etc.,

"DIVES."

The Costing Report

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—It is to be regretted that time did not permit of discussion on the Report of the Costing Sub-Committee. The subject is, however, of such importance that I would like to trespass upon your space to refer to some of the conclusions given in the Report.

I would like first to congratulate the Sub-Committee on the way in which they have tackled this difficult and controversial subject. I think they were wise in confining themselves, in the main, to laying down general guiding principles, as experience shows that each business must work out its own method in detail to suit its own work and to conform generally with its own organisation.

There are several points upon which I differ from the findings of the Sub-Committee, but I will confine myself to two of them. The first is the value of the metal. The method of arriving at this value is, I suggest, incorrect, although I agree with the answer obtained. Surely the home scrap has no value at all. It is true that certain charges have been incurred in direct labour and on-costs in melting this scrap, but these charges have been transferred to the account of the good castings, and its value on returning to the cupola is nil. The amount of home scrap produced per ton of good castings must be ascertained over a long enough period to secure average results in order to determine the proportion charged, which must be equal to that returned. The cost of the metal itself is that which is in the good castings plus the metal lost. A simpler and more convenient way of stating the cost of the metal is per ton of good castings, and mixture "A" would be stated thus:—

	s.	d.
10½ cwts. pig-iron (*a*) at 80s. ...	42	0
5¼ cwts. pig-iron (*b*) at 70s. ...	18	4
5¼ cwts. bought scrap at 50s. ...	13	2
21 cwts.	73	6

The lost metal is taken at 5 per cent. of the good castings, and is equivalent to that given in the Report.

The second point upon which I should like to make some comments is that of the on-cost recovery. I must join issue with the Sub-Committee on their statement that the simplest and soundest method is that based on direct labour. This implies that no other method is as simple or as sound, a statement that can hardly be substantiated. The conditions of wages and methods of payments in foundries are such that the nearest approximation to accuracy in the distribution of on-costs is the method of hourly rates. This method provides for the variation in cost of service provided for the different classes of direct workers as well as for the time during which they utilise these services. Every foundry has a limit to the number of productive hours available, and each productive hour has a definite financial value according to the facilities provided for the operation performed; unless these two factors, service and time, are taken into account in distributing the indirect charges, there is the probability that some castings are being overcharged and others undercharged, which would tend to cause unprofitable work to flow into the foundry and keep the more profitable lines away.—Yours, etc.,

E. R. BRIGGS.

The Mound,
Lawford Road, Rugby.
June 11, 1937.

I.B.F. v. W.M.A.

This cryptic caption means that on Sunday, July 4, the second annual cricket match for the Lichfield trophy between the Institute of British Foundrymen (holders) and the Works Managers' Association will take place at Lichfield. Full particulars are to be obtained from Mr. T. Makemson, St. John Chambers, Deansgate, Manchester, and most of the well-known Turf Commission agents will quote the latest betting!

(Concluded from next column.)

of the next Winter Session going without boredom.

* * *

Overheard at the Conference: Husband, finding wife with a sudden thirst for knowledge (most husbands, by the way, showed a marked tendency towards a thirst of a different kind): "To make pipes, Honey, you first get a long thin hole and then proceed to wrap it round with hot metal, spinning it round as fast as you can."

* * *

A London translation bureau undertakes to translate in forty-seven languages. The charges range from 6 words a penny to over 3d. per word—with 50 per cent. addition for technical work. What a blessing for the Institute that there is not an Exchange Paper at this year's Conference from Iceland, Tibet or Ethiopia! The day may come, however, and the Institute had better start a sinking fund at once against such a possibility. One never knows what will be the outcome of all this activity around the north pole, for instance.

MARKSMAN.

Random Shots

The sum of £500 has been given by the directors of Qualcast, Limited, towards a fund to help research within the foundry industry, whilst £400 has been granted by the Severn Fishery Board towards a biological research scheme within the trout fishing industry, and so two important research boards had reason to feel very pleased with themselves last week in Derby. Curiously enough, both are concerned with this all-absorbing business of casting—be it a line or be it a commodity in iron! The Derbyshire anglers, by the way, started their "mad fortnight" about June 10, that being the name they give to the period when the trout rise so madly for mayfly that any mutt can catch them. The foundrymen are more sober. They restrict their mad period to four days, and in that time they both work madly and play madly, whereas one suspects that the anglers only play.

* * *

It is a good thing, however that there is a lighter side to foundry conferences, for all work and no play, etc. (old adage too old to repeat in full), and when sitting through the reading of scientific Papers each morning it is pleasant to let one's mind wander to the treats in store for the evening. One such man, listening to a learned professor doing his stuff, allowed his mind to wander so freely towards the treats of the evening that he began to practice the intricate steps of the "Palais Glide" under his chair and eventually began to strum the strains of "The Lily of Lagoona" on his conference Papers. When this had become too much for the serious-minded metallurgist at his side (a man who had always been too busy acquiring knowledge to learn how to dance), he leaned over to the neighbour and said "I am sure that the Professor won't mind if you keep that appointment that you've got outside!" Whereat the offender got up and went out.

* * *

It was a happy thought of Mr. Winterton to present Mr. Gale with a rattle for his wife's newly-born infant, and it was a good thing that he parted with it early in the proceedings, or else one might have suspected him of feeling the need of something to play with after having dispensed with the chains of office! Mr. Bigg, in his presidential address, stressed the need for attracting the right personnel to the industry, so now Mrs. Gale will know just what to put her son to. Or is she a daughter? If so, even foundrymen need wives, as Mr. Bigg himself clearly demonstrated when trying to adjust the chain round his neck. Some even become Mayors, like Mrs. Petty of Derby—no mean accomplishment, in spite of the name.

* * *

One foundryman's little daughter told her daddy that she knew at least one Mayor of London, and that was Mr. Winterton, for had she not seen him in his chains? Ah, well! who knows that now he has forsaken the foundry chain of office whether he will one day adopt the Mayoral chain? or should one say rather, the Provost's chain?

* * *

When two or three foundrymen are gathered together in dark corners of their hotels at conferences it is their habit to tell stories, and there is, moreover, a regrettable tendency for the more Rabelaisian of these stories to be greeted with the remark, as the hallmark of approval, that they are good enough for "Marksman." "Marksman" wishes to protest. He has entirely reformed and no longer feels that he can put scarlet stories down in black and white. Of course, anybody who would like to have access to his private files could stock himself with a supply sufficient to keep the whole

(Concluded in previous column.)

Conference Visits to Famous Foundries in the Derby District

There is no locality in England richer in modern foundry establishments than the East Midlands, and the works visited last week by the members of the Institute of British Foundrymen by no means exhaust its resources. The choice made, however, was essentially representative, and everybody was appreciative of the enterprise and courtesy exhibited by the directors of the foundries inspected, to whom the thanks of the industry are due. Below we give brief descriptions of these well-known enterprises

Bamfords, Limited, Uttoxeter

AGRICULTURAL IMPLEMENT CASTINGS

Introduction

Founded in 1871 by the late Mr. Henry Bamford and his eldest son, the late Mr. S. B. Bamford, Bamfords, Limited, of Uttoxeter, have become since that time one of the world's leading manufacturers of agricultural machinery. In addition to implements for the farming industry, a large range of internal combustion engines and pumps is produced, and these, in common with the firm's other manufactures, are exported to all parts of the world.

In 1913, Bamfords, Limited, were appointed by Royal Warrant as agricultural engineers to

BUCKET ELEVATOR FOR CHARGING THE LARGE CUPOLA.

His Majesty the King. They are holders also of a number of the Royal Agricultural Society's Silver Medals. Among the amenities provided by the directors for their employees is a club with facilities for billiards, reading, bowls and social entertainment generally.

The works cover an area of over thirty acres, and besides the foundry, a detailed description of which is given below, include machine shops, a press shop, heat-treatment section and engine testing department. Lighting throughout the works is by means of Royal Ediswan "Escura" mercury discharge lamps. The light from these is very penetrating and makes them extremely suitable for use in the foundry, where they are used very successfully without colour correction. Power for the whole works is obtained from the "grid" at 230 volts.

Melting Practice

From the stockyards, which have a capacity of about 2,000 tons, pig-iron, scrap, coke and limestone are delivered into trucks, the contents of which are measured by weighbridges set between the rails. Charging is automatic, raw materials being transferred by hand from the trucks to 1-cwt. continuous hopper elevators which serve each cupola, and which were designed and installed by Bamfords themselves.

Three cupolas are worked, having melting rates of 6 tons, 3 tons and 2 tons per hr. respectively. The largest of these was specially built to the firm's own design, the last two being by the Constructional Engineering Company, Limited, of Birmingham, and T. Davies & Son, Manchester, respectively. Blast for the large cupola is obtained from an independently-driven 30-h.p. rotary blower by James Keith & Blackman Company, Limited; under normal working conditions this delivers 180,000 cub. ft. of air per hr., and the supply is checked both for pressure and volume by meters permanently connected to the plant. Blowers for the smaller cupolas consume about 15 h.p. each, and are operated from line shafting driven by a 100-h.p. electric motor, which also serves a Broom & Wade, Limited, air compressor; this delivers air at 90 lbs. per sq. in. to the foundry air-line. Cupolas are tapped into half-ton bogie ladles for distributing the metal to the casting floors.

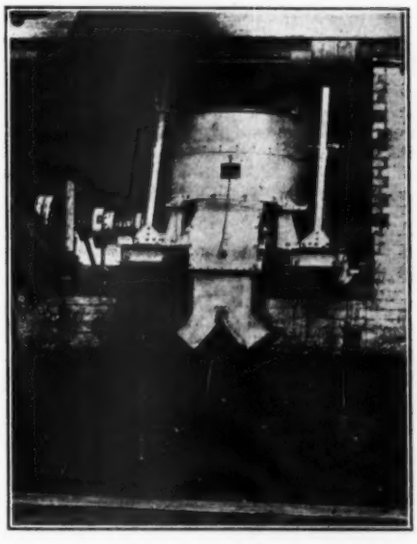
Approximately 100 tons of grey castings are produced per week. Included in the output of grey irons are certain amounts of special iron, mainly used for gears and cylinder liners, produced from pig of specified analysis. The mechanical properties of all grades of iron produced are tested daily on a Tangye deflection testing machine, a minimum figure of ¾ in. at 8 cwts. on a 3 ft. and 1 lb. square test-bar being specified.

Sand Department and Core Shop

Sand for the moulding shops is mixed in an August's Simpson No. 1 mixer. The machine has a capacity of 50 cwts. per hr. and is operated from the line shaft; about 10 h.p. is required to drive it. Coal-dust averaging about 150 mesh is produced in a Bamford "Rapid" mill situated alongside the mixer.

The recently-completed mechanised core shop is of particular interest and presents many unique features. Sand is delivered in trucks to a bay containing a coal-fired sand drier by Foundry & Engineering Company, Limited; this machine operates continuously. The dried sand is then mixed in a Rotoil mixer from which it is passed on to the core-makers. These operatives are positioned at benches on either side of a 2-ft. steel band conveyor operated by a chain drive from a 1-h.p. motor through gears giving a ratio of 1 : 600, and moving at 6 ft. per min. This band is so remarkably steady that coins balanced on edge will travel from one end to the other without falling over; there is thus little danger of the most fragile core being damaged by shaking.

Finished cores on core plates are pushed from the bench on to the band conveyor, and are carried along to a "stop" at the far end of the machine, at which point they are pulled off on to a steel table from which an operative removes them to a coke fired Acme continuous oven. Two ovens are provided (one being maintained as a standby), each being 8 ft. sq. and 20 ft. high. Dried cores are run out on trucks to the foundry, while core plates are returned to the core-makers on a Morris gravity roller system. This system



SAND MIXING PLANT.

is located about 6 ft. from the ground directly above the band conveyor, and is thus within reach of the core-makers who are, in addition, supplied with mixed sand by means of the band conveyor. It will be seen that the lay-out of plant in this shop is such that no operative need move from his working position either for disposing of finished jobs or for renewing supplies of raw material.

Casting Shops

The foundry is divided into four sections dealing with heavy castings, light castings, wheels and non-ferrous work. In the heavy casting department are two Britannia jolting machines with capacities varying from 10 cwts. to one ton,

and twelve turnover machines. The boxes used in this department are in most cases of the firm's own manufacture. Sand is mixed and aged overnight in a Royer mixer.

A wide variety of castings is produced, some weighing as much as 3 cwts. In contrast to this, the light casting section deals with work weighing as little as half an ounce.

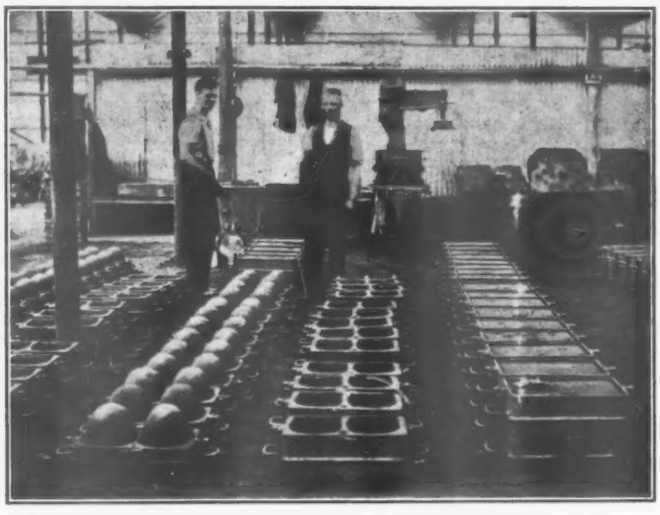
Some thirteen hundred moulds per day are produced on eighteen jolt-squeeze machines by male and female labour in the light casting shop. Sterling boxes are exclusively used in this department, the smallest job produced being washers, which are cast two dozen to the box. Among other light work may be mentioned a carburettor needle valve weighing about a third of an ounce.

The wheel shop is mainly concerned with the manufacture of road-wheels for agricultural implements of various types. These are made by casting hubs on a set of wrought iron spokes, which are afterwards riveted to rims. Six Britannia jolting machines, a "V & S" machine and one machine supplied by the British Moulding Machine Company, Limited, of Bermondsey, are employed in this shop. Certain features of the last machine deserve special comment. Owing to the particular nature of the work undertaken on it, allowance has been made for a 12-in. draw. Turnover is by pneumatic power, and may be set so that the machine slowly returns to its normal position while the operator is temporarily engaged on other work. The machine is operated at 85 lbs. per sq. in. from the shop air line, and considerable economy in air is effected by the vibrator mechanism being actuated from the exhaust of the squeeze.

Discs for Bamfords chain pumps are cast on to chains in permanent moulds, this operation being carried out in a separate department.

Approximately one ton of brass and phosphor-bronze bushes and bearings are produced per week in the non-ferrous foundry, which is equipped with a Cumming's coke-fired portable furnace. These castings are mainly used in the construction of the petrol, paraffin and Diesel engines manufactured by the firm, and in order to ensure satisfactory quality in the metal, pouring temperatures are controlled by means of a Cambridge portable type thermo-electric pyrometer. Shells are white-enamelled in a subsection of this department.

Light Castings Shop.



One Day's Production from a Single Moulding Machine.

Machining and Erecting

Castings from the foundry are conveyed by truck to the machining section, which sends on the finished components to the erecting shop. Flywheel castings require only turning, balance being achieved by the presence of balancing slots provided in the initial casting; the position of these was determined by previous experiment, and the steady-running of the finished engine demonstrates the satisfactory nature of this procedure. Attention might also be directed to the accessibility of the Bamford engine obtained by the use of a patent hinged bottom half casting which enables the crankshaft and connecting rod to be at once examined or dismantled by merely swinging back the cylinder block.

Pressed components are forwarded to the erecting shop from the press department which is provided with a number of presses of the fixed and inclinable "C" frame type by Hordern, Mason & Edwards, Limited, and other makers. As an example of the work turned out on this section may be quoted the oscillating connecting rod for mower cutter-bars, which is fabricated from two semi-elliptical pressings by oxy-acetylene welding.

The writer wishes to thank the directors for permitting him to visit and inspect their works, and in particular desires to acknowledge the assistance rendered him during this inspection by Mr. R. Bamford, G.I.Mech.E., Mr. A. E. Cotterill and Mr. F. Butters, A.M.Inst.B.F.

Ley's Malleable Castings Company, Limited, Derby

EUROPE'S LARGEST MALLEABLE FOUNDRY

In 1874 the late Sir Francis Ley, Bart., laid down a foundry at Derby for the production of black-heart malleable cast iron, the modern development of which is the largest malleable iron foundry in Europe, and it is certainly amongst the best equipped. It is generally true to say there is always room for the best, and there is no doubt whatever that the founder of the concern and those upon whom the conduct of the business has since fallen have kept that axiom prominently before them; from the outset and through the succeeding years, quality of production has been the first consideration. Small wonder perhaps, that the end has justified the means, and the growth of the business has been consistent and rapid so that extensions have been almost constantly in progress. The works, situated as they are within about a mile of the centre of Derby and bounded on the one side by the main L.M.S. lines from Birmingham to the North, have good transport facilities.

The Patternshop

The equipment of the patternshop is that common to the up-to-date shop though it may be noted that some of the machines of a more or less special character were designed and built by the works staff. Metal patterns are used almost exclusively, and for this duty the metal is brought down in two coke-fired pit furnaces. In the shop are assembled the lathes, drilling machines, etc., for finishing the metal patterns. The greatest care and considerable ingenuity has been exercised in the lay-out and organisation of the pattern stores, and despite the fact that some thousands of patterns are in regular service the system of indexing is such that any particular pattern can be instantly located.

The Foundries

The original foundry occupies a building 744 ft. long by 153 ft. wide to which was later added an annexe 250 ft. long by 75 ft. wide which is exclusively devoted to the production of links for chains. Attached to this annexe is the grey-iron foundry, the melting plant for which consists of a cupola of 3½ tons per hour capacity. This output is consumed in the company's own shops.

The melting plant in the old foundry comprises one 10-ton and five 6-ton air furnaces giving three heats per day, it being the practice to cast alternate days. There is also a 5-ton rotary furnace which was put down in 1927, but which at the present time is not in commission.

In 1926 the congested condition of the existing foundries made extensions imperative and an entirely independent foundry was built on the opposite side of the stocking ground. This foundry is housed in a building 362 ft. long by 164 ft. wide. It was with the erection of this foundry that the company determined to adopt pulverised fuel as the furnace-firing medium. In this direction they were, of course, pioneers, facing an entirely new set of conditions, and it is not surprising that at the outset they met

many difficulties, had many disappointments; but being thoroughly convinced that the principle was sound, they devoted themselves to the development of details, the outcome being that they have to-day a soundly practical and commercial, and highly efficient system of melting with pulverised fuel. As the pulverised-fuel firing has also been applied to the 24 annealing ovens and four re-heating furnaces, it is a subject of direct interest to the foundry industry, and later in this article it is proposed to treat it at some length. In the meantime, however, it may be pointed out that there are very direct economies resultant from the application to the air furnace. The fuel consumption per ton of metal melted is approximately the same, but larger charges can be worked, further no manual labour is required in handling the fuel, and the temperature is under more exact control. It is perhaps not easy to express these economies in terms, but the waste heat from the pulverised-fuel fired furnace which is turned to account is a direct and concrete economy.

PULVERISED-FUEL FIRED AIR FURNACE, WITH WASTE-HEAT BOILER.

CORE SHOP WITH VERTICAL CONTINUOUS STOVE, CORE BLOWERS, ELEVATOR AND HOPPER ABOVE MIXERS, AND A STEEL-BAND CONVEYOR.

In 1934 further extensions had to be made, and the demand for additional space was met by extending the length of the old foundry by 342 ft. and at the same time building a new foundry 368 ft. long by 152 ft. wide; this last is tandem with but independent of the foundry built in 1926.

The melting plant in the extension of the old and the two new foundries comprises in each two 20-ton air furnaces. These furnaces are placed back-to-back and exhaust to a Stirling waste heat boiler, which is common to the two furnaces. The boiler has a rating of 17,000 lbs. evaporation per hr. at a pressure of 210 lbs. per sq. in. and superheated to a total temperature of 650 deg. Fah. for service in the power house. The furnaces are worked alternate weeks, and it is the practice to renew the wall on one side each week, the lining may thus be said to have a life of a fortnight, although with solid-fuel firing the life would probably extend over three weeks.

In the 1926 extension, in addition to air squeeze and jolt machines, there are four Sandslingers of the tractor type by Foundry Plant & Machinery, Limited. This foundry is laid off for the production of the heavier castings, the output being approximately 100 tons a week. With the exception of the Sandslingers the equipment of the 1934 extensions is on similar lines.

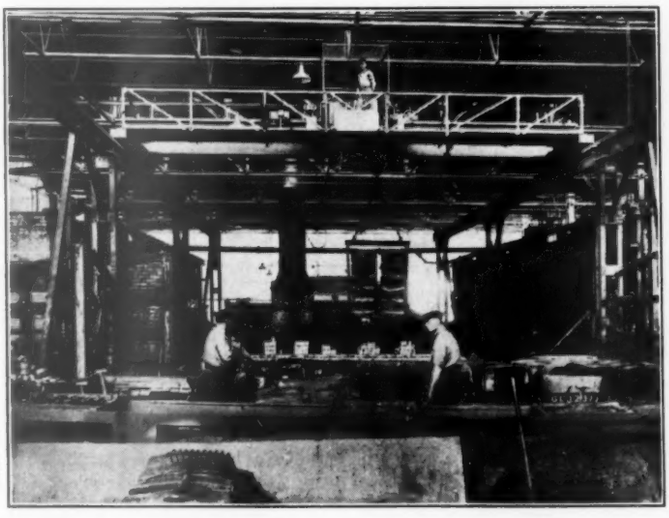
Air heaters are installed in connection with the pulverised-fuel fired furnaces, which deliver heated air through pipe mains along the top portion of one side of the shops, whilst on the opposite side are ranged a number of exhausting fans; there is thus always an adequate circulation of warm fresh air in the winter, and in the summer the heaters are used to pre-heat the secondary air for the furnaces and the fans then merely serve to circulate fresh air.

The Sand Plant

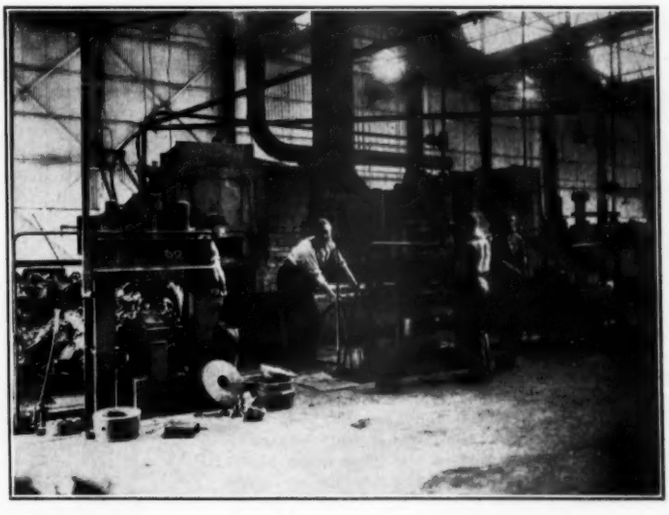
The sand plant is at present in a state of transition, and is being replaced by a sand plant manufactured by Pneulec, Limited, which will permit complete sand control. Practically all moulds are made in green-sand, Mansfield and Nottingham sands being used. Oil sand is used for the cores.

Core Making

Core making is carried out in three adjoining shops, which are equipped with the latest core blowing machines. The cores are delivered on steel band conveyors to coke-fired vertical stoves of the Acme continuous type, and discharged from the stoves on to the same conveyors, from which they are passed into stock or direct into the foundry if the necessary requisition is forthcoming.



BATTERY OF EIGHT PULVERISED-FUEL FIRED ANNEALING OVENS.



STRAIGHTENING PRESSES WITH REHEATING FURNACES.

Annealing and Finishing

Upon the subsequent treatment of the castings mainly depends the character of the finished

product and the first process may be described as the hard cleaning. The castings as they leave the moulds are subjected to shot-blasting in rotary barrels or on revolving tables, as the case may be.

After the hard cleaning the castings are passed to the inspection bench where they are examined prior to being sent to the annealing shops. In all there are 24 annealing ovens, all of which are fired with pulverised fuel. In the most-recently equipped shop the boxes are packed on hydraulically-operated lifting tables, the packing material being raised from a below-ground bunker by a bucket elevator and discharged into a hopper above the table. The packed boxes are handled by a 3-ton crane fitted with a cradle which lifts the boxes and places them on the bogie which is travelled into the furnace.

The total weight of castings is about 25 tons and the gross weight, *i.e.*, with pots and packing, about 65 tons per oven charge. Pyrometer readings are taken from the centres of the pots at each end of the bogie. The total time taken to anneal a charge is approximately 8 to 10 days, each served by two 5-ton cranes for charging and also for handling in repairs. It will be understood that the furnace bay is practically divided by the waste-heat boiler and its auxiliaries, so that the operation of the cranes is confined to their particular furnace.

Laboratories

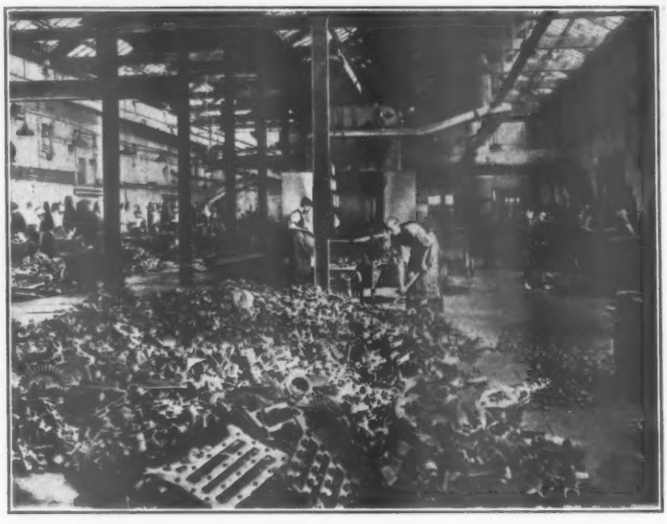
Both the chemical and physical laboratories are thoroughly well equipped, the former alike for routine and research work. Chemical control commences with the raw material, and continues to the finished product. Needless to say, all temperatures are recorded by pyrometers. The metallographic laboratory is equipped with the usual apparatus for preparing specimens, and a Leitz microscope and photographic apparatus is also installed. Included in the equipment of the physical laboratory is a 30-ton Avery universal testing machine, a Humphrey autographic notch-bar tester, and an Avery self-indicating hardness tester. An auxiliary of which mention may be made is a small Detroit electric melting furnace, which is fitted with an automatic rocking arrangement; the rocking action

The raw coal is washed smalls (1½ to ¾ in.), and as received contains approximately 15 per cent. moisture. It is discharged from the railway wagons into a 10-ton receiving hopper, which is fitted with a grid to prevent the entrance of foreign matter. A 20 in. apron feeder leads from the hopper discharge to the foot of a bucket elevator, which is placed between two 200-ton silos, and to the top of which the coal is raised at the rate of 15 tons per hour; a three way valve at the point of delivery from the elevator enables the discharge to be made into either of the silos or into a shute leading into a 20-ton raw coal bunker. The silos have conical bottoms to facilitate drainage, and are fitted with three openings with rack and pinion gates for discharge on to two screw feeders (one for each silo); these deliver to the boot of the elevator. It will thus be seen that the raw coal bunker can be filled directly from the receiving hopper or from the storage silos as required.

Drying and Pulverising

In order to eliminate the possibility of the pulverised fuel packing, as also to enable the

FINISHING DEPARTMENT.



FINISHING DEPARTMENT WITH SAND WIZARD AT THE OLD WORKS WHICH HAVE BEEN MODERNISED.

careful records being kept of the temperatures throughout. On each batch of annealed castings, tensile, wedge and bending tests are made, the results being recorded against the batch.

The annealed castings are then subject to a final shot-blasting and afterwards pass to the grinding shop, where fins, etc., are ground off, if necessary. Air-bag filters are used in connection with the shot-blast tables, the efficiency of which is distinctly good.

A certain amount of distortion in the castings is unavoidable, these matters are, however, provided for by the installation of presses of various forms. There are hydraulic presses by Davy Bros., Limited, under which certain classes of castings, wheels for example, are upset hot. The presses are served for that purpose by a continuous furnace, the temperature at which the castings are passed to the press being about 650 deg. C. In other cases the castings are upset cold under presses, others, for example flanges for flexible pipe joints, under a drop hammer.

Stock Yard

The stocking ground, as previously stated, is conveniently situated between the foundries and is directly connected with the railway. Internal transport is by a 1-ton Royce overhead runway and a fleet of electric trucks which are speedy, and the fullest advantage is taken of their flexibility for maintaining clear gangways. The furnace bays in the extensions are can be set for any angle and any time period. Temperatures of 1,550 deg. to 1,600 deg. C. are readily obtained. The furnace is used for small quantities of high chrome alloys, and, assuming the furnace is under constant charge, the average time to melt is 45 minutes.

Power Plant

The generating plant consists of two Met-Vic high pressure turbo-generators, each of 1,300 kw. generating about 140,000 units per week. In the power house also is installed the compressor plant. This consists of two Tilghman compressors delivering at 30 lbs. per sq. in. pressure, which are driven through Vee-ropes by a Met-Vic motor, and an Alley-MacLellan compressor delivering at 100 lbs. pressure per sq. in., which is also driven through Vee-ropes by a Met-Vic motor of 240 h.p.

The Pulverised Fuel Firing System

There are two complete pulverised handling and storage plants, but as both were supplied by the Fraser & Chalmers Engineering Works of the General Electric Company, Limited, it will meet the purpose if only the latest installation is dealt with. This plant supplies two melting furnaces, eight annealing ovens, two reheating furnaces, and is also able to supply one of the waste-heat boilers when the waste heat is not available.

mill to give its full rated output with the best economy in power, drying is essential. The raw coal is therefore fed at the rate of two tons per hour to a Ruggles-Coles type dryer, in which the moisture content is approximately reduced from 15 to 2 per cent. The drying media are the hot gases from a small hand-fired furnace, burning about 45 lbs. of coal per ton of coal dried.

The fines carried away by the exhaust gases from the dryer are recovered in a Fraser & Chalmers Cheltnam "Micron" precipitator, which is capable of dealing with 1,800 cub. ft. of gas per min. The dust precipitated is fed through a dust pipe and rotary air-lock to join the dry coal as it leaves the dryer.

The coal which is now ready for pulverising is passed through an Avery automatic weighing machine to a surge hopper, from which an adjustable screw feeder delivers it to an air-swept ball-mill of the Hardinge type, in which the coal is pulverised or ground at the rate of 2 tons per hour, so that 85 per cent. will pass through a 200 B.S.I. mesh. The coal-laden air is cleaned by a fan and delivered to the top of a cyclone separator; the settled-out coal is then passed through a rotary air-lock and a two-way shute into one of two 15-ton storage bins.

The mill operates in a closed circuit, the air from the cyclone returning to the mill *via* a classifier. The air circuit is provided with a slight vent to compensate for any leakage on

the suction side, and in order to keep the plant free from dust the vent is tapped to a Roots blower, part of the air being thus taken to a bag filter. Any dust recovered from this filter is taken through an air-lock to the storage bin. It may be noted that the controls are interlocked so that the plant cannot be started up other than in the proper sequence.

The pulverised fuel is distributed on the Fraser & Chalmers system, in which primary air is blown through pipe lines, the coal being sucked in at suitable points. Three fuel lines, each containing an injector, are in service, the longest being 440 ft. Two lines lead to the 20-ton melting furnaces and one to the waste-heat boiler, enabling the latter to be provided with an auxiliary supply of fuel when the temperature of the flue gases from the furnace is not sufficiently high to generate the steam required. The primary air-supply is provided by two fans, each of a capacity of 3,000 to 4,000 cub. ft. per min. at 21 in. w.g.; these fans discharge into a header feeding the injectors through suitable control valves.

The eight annealing stoves and two reheating furnaces are fed from a further circulating main, through which air, saturated with coal-dust, is passed by one of two blower fans, each having a capacity of 1,750 cub. ft. per min. at 25 in. w.g. The annealing line can be vented to the bag filter so that the whole system can be emptied of coal when necessary.

The primary air fans are driven by 22 h.p. motors and the booster fans by 18 h.p. motors, the normal duty is taken by one of each of the fans, the second unit in each case standing by. The pulverised coal for the fuel lines is fed through flexible pipes from three 8-in. feed screws at the bottom of each storage bin, each of the screws is driven through a gearbox by a 1½ h.p. variable speed d.c. motor, the capacity of each screw ranges from 1,200 to 3,600 lbs. per hr., being, of course, dependent upon the speed. Four flexible connections are provided and are interchangeable, allowing any feed screw to discharge into any injector or circulating main as required, and as each screw operates independently, the arrangement is extremely flexible, giving a wide range of feeds and alternate feed methods.

Each of the storage bins is also provided with a 10-in. feed screw driven by a 2-h.p. variable speed motor, these screws discharge outside the building, so that if required the bins can be emptied into containers on adjacent rail tracks.

From the foregoing it will be apparent that every possible contingency has been provided for, and the plant in its entirety is representative of the soundest modern practice in the centralisation and distribution of pulverised fuel.

Herbert Morris, Limited, Loughborough

MECHANICAL HANDLING EQUIPMENT

Herbert Morris & Bastert established themselves in London in 1884 for the manufacture of lifting tackle, and became specialists, perhaps, in advance of the general appreciation of the value to-day, one might say the necessity, of specialisation.

For some years progress was slow, but at the same time it was consistent. The business was converted into a limited liability company under its present style in 1900, when a site was acquired at Loughborough fronting on to Empress Road and bounded on the opposite side by the Leicester Canal, and because the site was conveniently near the lines of the L. & N.E.R., it afforded the possibility of connecting up with the works. It was in 1904 that the activities were definitely transferred to the Loughborough Works, and in order to cope with the ever-increasing business, adjacent sites were acquired and the works extended until the whole of the available space was occupied.

In 1920 the company took over the business of H. Coltman & Son, Limited, and developed the works for boiler making, and as at that time the company were building a considerable number of steam cranes, the boiler shop was an asset. In the meantime the company had extended the field of their activities by building conveyors and later became specialists in foundry mechanisation, both, one might say, natural developments for the builders of lifting tackle. Further extensions to works and plant became imperative, and in 1922 a site of 74 acres was secured at the other end of the town alongside the main line of the L.M. & S. Railway and adjoining the site of the boiler works.

Profiting by the experience gained at the original works, the lay-out of the new site was carefully planned with a view to future extensions, and it has since twice been necessary to make such extensions, the first by the erection of additional bays and the second by extending the whole of the bays longitudinally, and it will be in this direction that future extensions will be made, the ends of the bays being of a temporary nature in the meantime. It may, however, be noted that the present floor space occupied by the works exceeds 22 acres. Actually, the company occupy five works, known respectively as the North, South, East, West and the boiler works, each more or less self-contained.

It is not possible here to deal at any length with the equipment of the several works nor indeed would such a description be of interest to the foundry industry. It is proposed therefore to confine this article to a general outline. The original works are known as the East works, and here, fronting on to Empress Road, are situate the head offices of the company. What was formerly the general machine shop is now given up to the electrical assembly department. It may be pointed out that the company confine themselves to the manufacture of electrical machines or parts which are integral parts of their tackle, all independent motors being purchased.

In the lay-out of this shop the benches occupy the mid-position, with all machines in the side bay. The machines are of the most modern type by Dean, Smith & Grace, Kitchen & Wade, Stirk, etc. A narrow gauge track extends along one side of the shop and indeed for the full length of the works. The method of handling, however, is mainly by an overhead telpher system, which is singularly complete as it commands the whole of the shops by a system of switches.

The Smiths' Shop

The smithy, which adjoins, is served by two steam, one drop and three belt hammers. Whilst general forgings required throughout the works are made in this shop, the staple productions are crane hooks and sling rings. For certain duties the hooks are drop forged, whilst in other cases they are first roughly hand forged; all special hooks are entirely hand forged. The smithy equipment includes a coal-fired furnace which is used for normalising or special heat-treatment.

The Foundry

The foundry is run on separate establishment lines for the production of castings in grey iron and non-ferrous metals, *i.e.*, brass, bronze and gunmetal; other alloy castings are bought from outside. The foundry floor is divided into two sections, one for loose-pattern pit and loam work and the other for repetition work, all patterns for the last being in either brass or aluminium, chiefly the former. The foundry equipment includes modern pneumatic machines of several types, portable electric mould dryers, portable electric riddles, etc.

The melting plant consists of two cupolas fitted up on the Poumay system, which are worked alternatively and are each blown by a Keith Blackman motor-driven fan. The charging platform which is outside the foundry building and is served by an electrically-driven hoist, is capable of carrying a full day's supply of material.

Naturally the quality of the metal is a vital factor in castings designed for lifting duties, the iron therefore is close grained with a comparatively low silicon and a very low phosphorus content. Test-bars, which are cast with every melt, are subject to transverse and tensile tests, combined with a systematic analysis. Non-ferrous alloys are melted in a coke-fired Morgan tilting furnace of 400 lbs. capacity.

The sand is prepared in a self-contained automatic plant, Royer throwers also being used, and the floor of the foundry is served by three 1-ton and two 50-cwt. cranes in addition to jib cranes and the telpher system already referred to.

In the core shop is an oil-sand mixer and core making machines. The output of the foundry is made up of castings weighing from a few ounces up to 3 tons.

The fettling shop adjoins, but is separately housed, and the equipment includes a git cutter, Tilghman's sand blast room, two tumbling barrels and double head grinder, with a full complement of pneumatic hammers. In the fettling shop all castings are subject to a rigid inspection, and it speaks well alike for the product of the foundry and the thoroughness of the inspection that the rejects in the machine shop are less than 1 per cent.

The Patternshop

The patternshop is adjacent to the foundry and here both the wood and metal patterns are dealt with. The equipment generally is on standard lines, but mention may be made of the use of portable electrically driven tools such as bench saws, flexible-drive drills, etc. Whilst the main pattern stores are housed in a fireproof building between the foundry and the patternshop, there are also five self-contained buildings which serve for pattern storage.

On the stocking ground for the foundry, pig-iron, etc., is carried on one side and coke and sand on the opposite side, the ground being spanned by a gantry carrying a 10-ton crane.

From the fettling shop, the castings are loaded up into containers and delivered to the exit of the works whence they are picked up by the telpher system and taken to the South works and stacked on the ground and allowed to weather for three months.

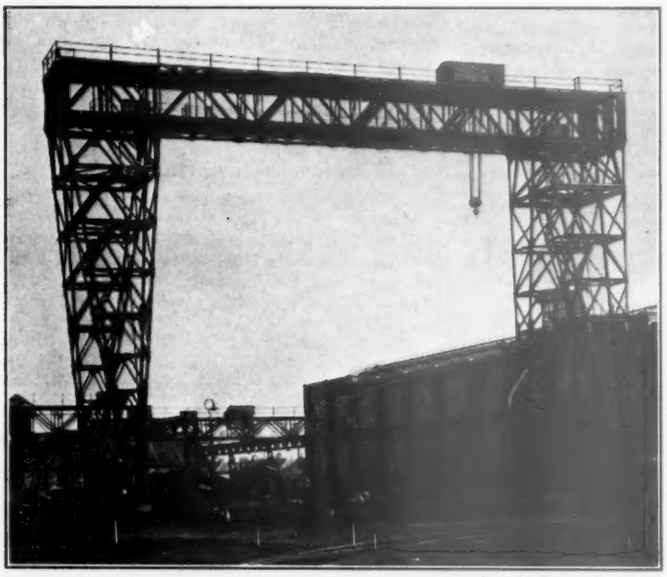
The South Works

Actually the South works occupy the first floor of the building, the ground floor being laid out as a castings stores, section stores and canteen. Elevators are employed for transferring materials from the basement to the shop floor, and one has been specially designed for handling bars. This consists of a series of bars placed between two chains which are fitted with fingers to pick up the bars one at a time from the delivery end of an inclined table upon which they are loaded in the stores. The carrying fingers tilt on reaching the shop level and throw the bar off on to a second inclined table from which they are picked up as required.

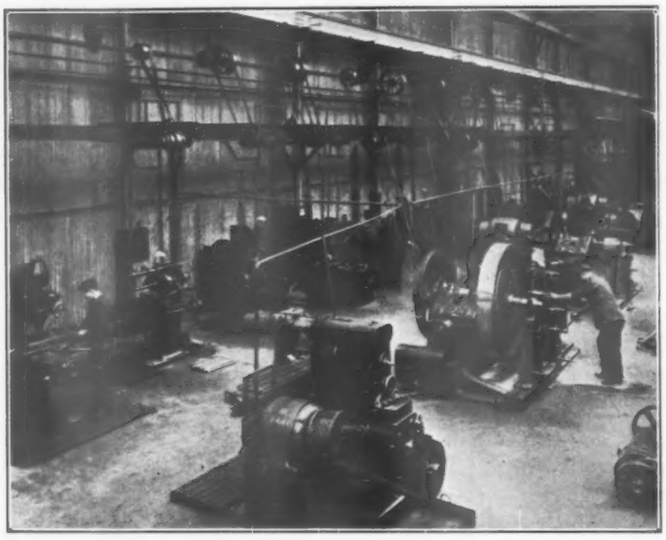
The stocking ground for sections is tandem with the end of the shop, the spanning gantry being served by a 5-ton crane. On the stocking ground are installed cold saws, drills, angle

and girder cutting machines and an installation of oxy-acetylene cutting plant. All sections are cut on the ground to dead lengths and any heavy drilling is also done. One section of the stocking ground is laid off for a machine for testing overhead runways.

The works themselves are contained in a building 480 ft. long by 180 ft. wide, and are laid out almost entirely on a quantity production basis for the manufacture of lifting blocks, both electric and hand types, which are usually put through in batches of a 100. For all practical purposes the shop is laid out in two parts, the one containing a number of machine bays each side of a central aisle and the other with a series of assembly bays for different types of blocks, gravity and overhead chain conveyors.



25-TON GOLIATH CRANE AT THE NORTH WORKS OF HERBERT MORRIS, LIMITED.



GEAR-CUTTING SECTION OF THE NORTH WORKS OF HERBERT MORRIS, LIMITED.

It is not necessary to detail the various machines, but they include a battery of modern gear-hobbing machines, gear-cutters, milling, drilling and boring machines, lathes, automatics and semi-automatics, etc., which for the most part are driven in groups.

All blocks are tested to 50 per cent. above rated loading. The method of applying the test is through a built-up frame with a series of projecting fingers which are designed to be engaged by the shackles fitted on to weights which are housed in a pit below floor level, thus by the addition of weights any desired load can be obtained. The trestle which supports the block is mounted upon rollers, so that it serves a series of pits each containing various weights.

On the one side of the shop is a well laid out tool stores and on the opposite side is situated the general stores which are also served by the overhead telpher system, the rails running over the bins.

Whilst both hand and battery trucks are in service in the shops and ample gangways are maintained for their freedom of movement, for relatively long distances the overhead system is preferred as being the more convenient as well as the more economical.

Heat Treatment Shop

The hardening and heat-treatment department forms a separately built department containing producer-gas, town-gas and electric furnaces, with the necessary equipment for the close control required for the treatment of the carbon and alloy steels so largely used.

Sheet Metal Working Shop

This department is equipped with machinery, complete with spot and arc welders, for dealing with the varied requirements in sheet steel fabrications called for by the electric crane, hoist and conveyor departments, as well as the body work for the Morris Versatile Crane.

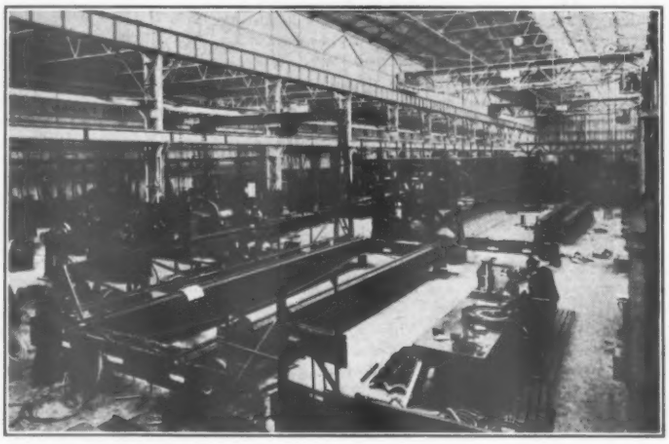
The Chain Making Bay

All chains are butt-welded, the steel is cut to length and the chain then formed in a special machine to be afterwards welded on one of the four machines, the latest of which are practically automatic. After welding, the chain is ground around the weld, then passed through the tumbling barrel. The chain is machine tested for pitch, and fully examined for soundness of weld, heat-treated and proof tested to B.S.I. and Admiralty specifications on hydraulic testing machines.

The North Works

The North works are distant about half a mile from the East works, and, as previously stated, adjoining the lines of the L.M. & S. Railway between London and the North. Very ample sidings are provided in the works and a double set of tracks is laid in the mid position across the bays of the shop. The stocking ground which extends for the full length of the works, is served with a 5-ton crane and a fleet of petrol locomotives. In the stockyard is also a 25-ton Goliath crane with a span of 100 ft. and a clear lift of

NO. 2 BAY OF THE NORTH WORKS OF HERBERT MORRIS, LIMITED.



ERECTING ELECTRIC CRANES AT THE NORTH WORKS OF HERBERT MORRIS, LIMITED.

100 ft. which was installed for special crane erection work.

The works cover an area of upwards of 22 acres and consist of a building of seven bays. The main bays are provided with high and low level crane gantries. Obviously the cranes must be equal to dealing with the maximum load, and their movement is consequently relatively slow; it is therefore desirable to provide more rapid means of transit for the lighter loads. The whole of the crane equipment will not be dealt with, and only that of one bay will be outlined. The top gantry carries a 25-ton and a 10-ton crane, both fitted with auxiliary hoists. In addition to a 5-ton crane, the lower gantry, on one side, is travelled by a number of gantries each fitted with a 1-ton electric lifting block. These travelling gantries serve to handle the work for the smaller machines.

The machine equipment includes all types of gear cutting and gear planing machines. The machine tools are independently motor driven, and are representative of the most modern labour saving machinery available for the class of engineering work undertaken. Many of the tools are of a portable nature, an interesting example being an Asquith drill, which, mounted upon wheels, travels a track extending for the full length of the bay. This is a very convenient arrangement, as the drill is used, in the main, for plate work. Mention may also be made of a Clifton & Baird saw, which is mounted on a turntable and can be racked round to any desired position relative to the work to be cut. Cutting is also done by the oxy-coal gas process, while electric welding is used to a considerable extent on certain standard fabrications.

All cranes are tested to at least 50 per cent. overload, the electric testing plant and auxiliaries covering both a.c. and d.c. requirements up to 150 h.p.

The Boiler Works

The boiler works do not call for any special description. The works, being originally used for general engineering, mainly small steam engine building, comprise a complete series of shops, but at present only the boiler shop is in full commission, for the rest of the shops are only used on relief account of the main works.

The relations existing between the directors and staff, including some 1,500 time paid employees, are of the most friendly character, and the support given and the interest taken by the directors in the various works funds is highly appreciated.

Qualcast, Limited

A MODERN REPETITION FOUNDRY

Qualcast, Limited, is the modern development of a small foundry for the casting of stoves and grates which was established in Roscoe Place, Sheffield, in 1801. Activities were, however, transferred to Derby in 1849, where trading commenced under the style of the Derwent Foundry Company. Grates and stoves remained the staple productions until after the War, these manufactures were then discontinued, and the foundry was given over to the production of light repetition castings. The change-over was well conceived and the concern at once entered upon a period of prosperity.

In 1928 the business was converted into a public limited liability company under its present style of Qualcast, Limited. The demands of the market for light castings of really good quality were such that the existing foundries were speedily overtaxed, and even had space permitted, it would not have been possible to reconstruct the existing works to secure the most economic production.

The site selected, on Victory Road, is really in suburban Derby in a good class residential neighbourhood. The works are, however, set back some distance from the road and are approached by a drive, whilst the works themselves are fronted by lawns backed by a well-kept bowling green; on the one side is an attractively designed canteen and club rooms and on the other a well-equipped ambulance room. It is worthy of note that the ambulance room has not yet been used, although the works have been in operation since 1929.

Happily the day is passing when those responsible for the lay-out of the foundry regarded dirt and discomfort as inseparable from foundry operations. The capital expenditure by Qualcast, Limited, on what may be called the extraneous amenities, has not been heavy, and one cannot express in precise terms the interest on the investment, but indirectly the return on this expenditure must be considerable. The influence of the outside surroundings on those employed in the light, well-ventilated shops is reflected throughout the works, which is characterised with a neat and cleanly orderliness, such as one sees all too seldom in the foundry industry.

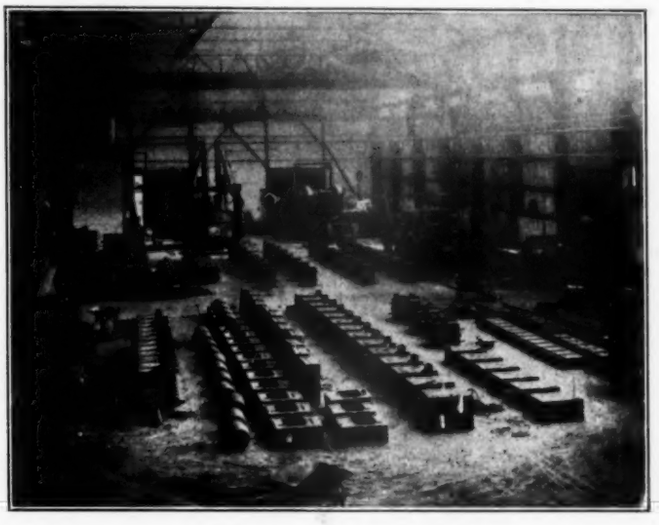
Transport

In the matter of transport the works are particularly well placed as the lines of the L.M.S. Railway bounds one side and the works sidings from this almost completely circle the works. The pig-iron stocks are carried along the sidings and right alongside the melting plant, whilst the wagons of coke travel the sidings direct into the foundry. The sand is delivered in a similar manner to the sand plant. Mansfield sand is used for general purposes and sea sand for the cores.

Sand Plant

The sand plant comprises a Pneulec aerator, a Simpson mixer and a rotary dryer. Used sand is passed through the aerator to the boot of an elevator into a cylindrical screen, the through material from which falls into a hopper, while the over-size and rubble is delivered into barrows to be tipped to the boot of an elevator feeding an elevated hopper of 70 tons capacity, from which it is loaded into wagons to be dumped. The outlet from the sand hopper feeds into the bucket of the Simpson mixer and at the same time the new sand is added; from the mixer the sand is conveyed by industrial track and travelling crane to the points of use.

GREY IRON FOUNDRY OF QUALCAST, LIMITED.



STEEL FOUNDRY OF QUALCAST, LIMITED.

Core Sand

The sea sand, after being dried in a coke-fired rotary dryer, is conveyed in hopper buckets by an overhead telpher system to the hoppers above the core sand mixers.

The core sand mixing plant was built by Chattaway & Son, Limited, and in it is embodied a somewhat unusual feature, which was designed by the Qualcast staff. This is a sand-measuring device, consisting of an auxiliary hopper at the outlet end of the main hopper, the auxiliary hopper being set to take a charge of 80 lbs. of sand. The outlets from both hoppers are sealed by doors which are mechanically interlocked, so that the one cannot be opened unless the other is shut. It is the practice in both mixers to work 400-lb. charges, *i.e.*, 5 charges from the measuring hopper, and to this charge the oil and water is added by weight, the sand is thus under perfect control and the mixture is a constant factor.

The present foundry for grey iron castings occupies a building 400 ft. long which is covered by eight bays, seven of which have a span of 25 ft. and one, the cupola bay, a span of 35 ft. The foundry and shops are warmed by elevated heaters and in the summer the fans serve for the circulation of cool air. The two main bays of the foundry are served by 1-ton overhead cranes, which also serve the machines and handle the bogie ladles of metal.

In all there are some 110 moulding machines which comprise the hydraulic, pneumatic and hand squeeze as well as jar-ram types. The machines are arranged in parallel lines on either side of the main gangways. An annexe to the shop is laid off for experimental work, for dealing with new patterns, etc.

The Melting Plant

The main melting plant, which is installed in the mid position in the cupola bay consists of two cupolas with drop bottoms each of a melting capacity of 12 tons per hr. Each cupola is served by a Keith Blackman fan; whilst the cupolas are worked alternatively, the fans are, however, interconnected and each can blow either cupola. The charge for the cupola is loaded into skip barrows which after being weighed on a crane weigher are delivered to the charging platform by electric hoist and then charged by hand. A cupola of 4 tons melting capacity has recently been added to the melting plant, but this in the main is devoted to bringing down special irons.

It is the practice to pour very hot, a temperature of 1,400 deg. C. being recorded by the disappearing filament pyrometer. Continuous tapping is adopted into 8-cwt. bogie ladles, many of which are of the closed type. The bogies travel a line of track at right angles to the bays, the ladle of the tilting type provided with feet is then delivered to the point required by one of the shop cranes and placed upon the floor, as all casting is done by hand ladle. The empty ladles travel the empty road to a " kick-back " from which they are again brought under the spout of the cupola.

Core Shop

The core shop occupies a building 240 ft. long by 50 ft. wide. The equipment includes seven core blowing machines and a number of Tabor moulding machines. The machines are arranged in parallel lines, each line of machines is served by a steel belt conveyor and a coke-fired Acme vertical stove. After drying, the cores from both stoves are loaded off on to an ingenious form of plate conveyor which encircles this portion of the shop, the plate members forming the conveyor are cut so as to take the small radii at the corners, from the outgoing side of the conveyor. The cores are put into stock to await the proper requisition. At the opposite end of the shop is a third smaller vertical oven, which is devoted exclusively to drying cores for the steel foundry and also assembled cores. It is worthy of note that the daily output of this shop is 20,000 cores.

The Fettling Shop and the Finished Stores

The fettling shop and the finished stores occupy a building 400 ft. by 70 ft. Castings are brought from the foundry to the fettling shop in floor trucks by the night shift, so that there is no interference with foundry operations. The fettling equipment includes three shot-blast chambers, with revolving tables by Tilghman's and Jackman; two shot-blast tumbling barrels, a full equipment of pneumatic chipping hammers, and two batteries of double head high-speed grinders.

The finished-parts stores are laid out in avenues of bins, each bin being provided with a card upon which is recorded the putting in or taking out of stock; the whole of the stock is thus continuously recorded.

To speak of the actual tonnage of metal poured in a foundry making castings from a few ounces in weight up to a maximum weight of 90 lbs. would convey little real idea of the actual activities of the foundry, and it is better expressed by the number of castings made, and in the grey iron foundry under notice the average output is 30,000 castings per day.

From the foregoing it will be seen that no attempt has been made at mechanisation, as the term is generally understood. The lay-out has, however, been so carefully considered and planned and the sequence of operations so simplified, that it is more than doubtful whether the problematical advantages resultant from mechanisation would justify the capital outlay.

The Steel Foundry

The steel foundry is housed in a building 225 ft. by 50 ft., which is served by a 2-ton overhead crane. A further similar size bay has been erected for future extensions, the floors throughout are laid in ferro-concrete. It was not until 1935 that Qualcast commenced the production of heat-resisting steel castings. The melting plant consists of a Stobie 3-ton electric furnace in which alloys of chrome steel are melted. The moulding machines comprise hand-operated Zimmerman and Pneulec turnover machines. A Smedley sand mixer is also in service.

The compressor house contains three Broom & Wade compressors, two of which deliver at a pressure of 90 lbs. and the third at a pressure of 30 lbs. per sq. in. Each machine is driven through Vee-ropes by a motor. Electric power is taken from the Derby Corporation supply.

The pattern shop and stores are in keeping with the rest of the works; the former contains the usual equipment of the most modern design, and the latter is laid out in two sections, providing for rack storage worked with the card system.

Costing

A very comprehensive system of costing is maintained, and in a very simple manner. As a typical example may be cited that of the moulding. A time is allocated in seconds for each individual operation of a given part in making a mould, and upon the sum total of the allocations is based the possible production of the number of such moulds per day. Ten per cent., however, is deducted from this figure before it becomes the basis for calculation, and for all production in excess of 60 per cent. of this basis the men receive a bonus of 50 per cent. As an example, if a labourer's piecework earnings were 1s. 4d. per hr., and his basis 10d., he would receive a bonus of 3d., making 1s. 7d. per hr.

Lawn Mowers

Although the manufacture of lawn mowers is somewhat outside our scope, it is interesting to note that whilst Qualcast commenced the production only some 14 years ago, they are to-day the largest makers of such machines outside the U.S.A. They have also the largest output in Australia, where they established a works in 1933.

One self-contained shop is devoted to the manufacture of lawn mowers; the raw material entering at one end passes in sequence through the manufacturing processes to leave the shop at the other end as a complete machine, tested and painted, ready for despatch.

Stanton Ironworks, Limited

WORLD'S LARGEST PIPE FOUNDRY

Historical Note

The village of Stanton-by-Dale first became noted for its iron towards the close of the eighteenth century, when this country was entering on the remarkable period of expansion known as the industrial revolution. In 1788 iron was made at Stanton in a furnace probably not more than 30 ft. high, and with a hearth about 3 ft. in dia. The blowing engine would no doubt be of the " atmospheric " type, working on leather bellows.

Blast-Furnace Construction

Little is known of the history of Stanton during the next forty years; but about 1842 the Company commenced the building of a new blast-furnace plant, which was completed and ready for use by 1845. For some years this plant probably consisted of three small furnaces about 40 ft. high, which were equipped with pipe stoves. New furnaces were erected in 1865 and 1867, and about the same time two blast engines, then considered to be powerful, were erected for the Company by Claridge North & Company of Bilston. Further furnaces were built during the boom in the iron and coal trade which followed the Franco-Prussian War of 1870.

A Branch Railway

A notable event in the history of the Stanton Company was the opening of the branch railway to Stanton Gate Station about 1884. This enabled minerals to be brought by rail from the Company's mines. Prior to this date the only railways serving the works had been those with narrow-gauge tracks used to convey ironstone from the local mines. Coal and other material were brought by canal, the same method of transport being also used for the disposal of pig-iron.

Twentieth Century Developments

In 1900 the Company began to build Cowper stoves for heating the blast prior to its introduction into the furnaces, and about this time Lilleshall blowing engines were installed. The Company's present offices were built in 1914. Except for the erection of a turbo-blower in 1916, the plant remained unaltered until the end of the Great War, when a pig bed crane was put into operation. In that year (1918) the Stanton Company acquired control of The Holwell Iron Company, Limited, whose four blast furnaces, each producing 1,000 tons of pig-iron per week, were rebuilt shortly afterwards.

In 1926 the Company decided to pull down their nine old blast furnaces at Stanton, none of which was producing more than 400 tons per week. These were superseded by the present plant of five modern furnaces, each of which produces a minimum of 1,200 tons per week. Three furnaces were lighted in 1928, and two further furnaces were completed in the following year.

Pipe Foundries at Stanton

For many years the name of Stanton has been inseparably associated with cast-iron pipes. The experience of successive generations has established cast-iron mains as the most durable and reliable medium for gas transmission and for water and sewage conveyance. It is on underground networks of pipe-lines that the great cities of the world depend for these essential services, without which civilised life could not continue for more than a day or two. Although under normal conditions cast-iron pipes will last indefinitely, the constant extension and enlargement of existing mains, due to the growth and concentration of population, is responsible for a continuous demand for cast-iron pipes.

Cast-iron pipes were first made at Stanton between 1830 and 1840, the original output being

between 400 and 500 tons per month. The casting of pipes was discontinued for some years prior to 1878, when the works were completely rebuilt and foundries were installed for the general production of pipes. Most of the monthly output of 500 tons was at first either sold in Britain or exported to the Colonies. By the end of the nineteenth century, however, the output of pipes had risen to about 12,000 tons per month, and the Company had extended their overseas markets to all parts of the world. During the War years the Stanton foundries were occupied with the production of munitions, and most of the Company's pig-iron was requisitioned for war purposes.

The Stanton Spun-Pipe Plant

One of the most important developments in the history of iron-pipe manufacture began in 1922, when the Stanton Company decided to erect a plant for the centrifugal casting of iron pipes by the de Lavaud process, then in an undeveloped stage. In the same year the Company built a plant for the centrifugal manufacture of concrete pipes.

The commercial production of Stanton spun-iron pipes was commenced in 1924, and the unique qualities of the new product were quickly appreciated by British gas and water engineers. Since that date the plant has been kept working at full capacity, and a further plant has been equipped for the production of spun-iron pipes in 6-yd. lengths and up to 21 in. in diameter.

Stanton To-day

The Stanton Ironworks Company, Limited, are to-day the largest manufacturers of cast-iron pipe in Europe. As their manufacturing plant is supplied with materials from the Company's own coal-mines, ironstone and limestone quarries, the Stanton organisation is classed as a vertical combination, as distinct from a horizontal combination, the latter being an amalgamation of companies making the same article but not possessing their own sources of raw materials.

The Stanton Company are, therefore, in the fortunate position of being able to exercise direct supervision over every stage in the production of cast-iron pipes, from the extraction of the raw materials and the manufacture of the pig-iron to the despatch of the finished product. Each week the Company produces approximately one hundred and fifty miles of pipes for gas, water and sewage conveyance, a substantial proportion of which is exported to many parts of the world.

The Stanton Property

The Stanton Company's four coal-mines, which are situated at Teversal, Pleasley, Silverhill and Bilsthorpe, have an annual output of approximately 2,500,000 tons. The annual output of the company's eleven ironstone quarries is about 1,300,000 tons, and that of their three limestone quarries is approximately 280,000 tons. The production of one ton of pig-iron requires $3\frac{1}{2}$ tons of ironstone, $\frac{1}{2}$ ton of limestone and $1\frac{1}{4}$ tons of fuel.

Within their works the company have about 75 miles of railway, carrying over 70 standard gauge locomotives and over 6,000 of their own railway wagons. A large proportion of the 14,000 employees on the company's various works are housed on the Stanton property, which includes several thousand acres of land, part of which is farmed.

New Plant at the Nutbrook Works

The original foundry of the Stanton Ironworks Company, Limited, for the production of spun-iron pipes on the Sensaud de Lavaud system had reached the limits of its output capacity, and it was apparent that substantial extensions would have to be made to the works and plant to meet satisfactorily the present and future demands. In the main the most substantial increase is for pipes of the smaller sizes, *i.e.*, of 3 in. and 4 in. in dia., more particularly, perhaps, the former. Rather than make extensions to the existing plant it was determined to lay out an entirely new foundry for the production on mass-production lines; by so doing it was possible to turn to the best advantage the experience gained during the past 14 years.

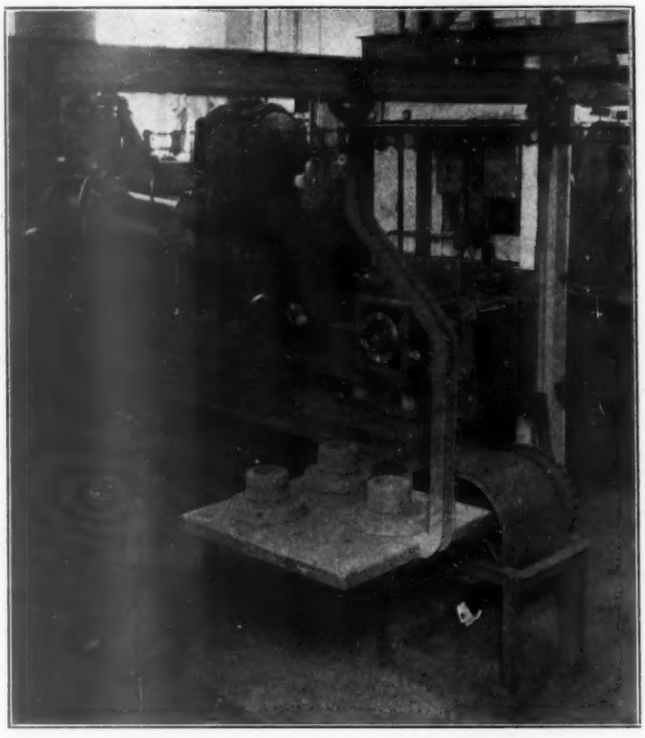
The site of the new foundry is that of the old Nutbrook Works, which was originally laid down for the vertical casting of pipes of 48 in. in dia. and upwards, but which had been out of commission for some time. Of the old foundry, only the buildings which lent themselves very readily for the conversion were retained. The first essential in the lay-out was, of course, a perfect balance throughout the process of manufacture, and second only in importance the reduction of handling, either manual or mechanical, to the narrowest limits. From an inspection of the plant it is at once evident that in the above respects the Nutbrook foundry leaves nothing to be desired.

Melting Plant

Iron is brought down in two cupolas each of 12 tons per hr. capacity; these are served by a common platform and are used alternately. The cupolas are of the Balanced-Blast type, continuous pouring, and are fitted with drop bottoms; the metal flows into receivers of 3 tons capacity and the slag into small slag pots. Blast is supplied by a Keith Blackman motor-driven fan, which is common to both units. The cupolas are skip charged; the skips, of 2 tons capacity, are loaded direct from the railway wagons, hauled over a weighbridge, and thence picked up by a 3-ton Vaughan telpher and discharged through side shutes into the cupolas.

From the receiver the metal is fed into 30-cwt. ladles, of which there are three suspended from 3-ton Vaughan blocks travelling on a telpher track, outwards along the line of spinners and returning outside the foundry building, the arrangement being such that whilst the one ladle is feeding the spinners a second is being charged from the receiver, a sequence of operations which is consistently maintained.

It may, perhaps, be interesting if we briefly restate the salient features of the spinners for the production of the spun pipes. The casings carrying the steel moulds, which are water cooled, rest on an inclined track. The moulds are electrically driven and are supported on anti-



TRANSPORTING THE SOCKET CORES ON A PENDULUM CONVEYOR FROM THE MOULDING SHOP TO THE SPINNING MACHINES.

A 30-CWT. LADLE BEING FED FROM A RECEIVER INTO WHICH METAL POURS CONTINUOUSLY FROM THE CUPOLA.

friction rollers. The socket cores are inserted into the bottom end of the mould. The casting ladle is furnished with a cantilever spout, the length of which is approximately that of the finished pipe. Longitudinal movement is given to the carriage hydraulically.

A predetermined weight of metal, according to the size of the pipe to be cast, is delivered from the service into the casting ladle. In the meantime the mould has been travelled to its highest position, so that the delivery spout is adjacent to the socket of the pipe. The motor driving the mould is then started up, and when the necessary speed of revolution has been attained, the casting ladle is tilted, causing the metal to flow in a regular stream into the mould, the mould at the same time being travelled outwards from the spout. This combined rotary and longitudinal travel results in a thoroughly sound casting of uniform section throughout and clean inner and outer surfaces. As the mould travels just clear of the teeming spout any surplus metal is run out into a catch-pot.

The pipe is ready for withdrawal immediately casting is complete. Such withdrawal is accomplished by gripping the socket with a pair of tongs, which rest in a fork member, and travelling the carriage back to the casting position, whilst the pipe rolls down an incline on to the transfer belt. At this stage the pipes are heat-treated in a continuous normalising furnace.

With the introduction of the Mairy process, which consists of applying a thin coating of ferro-silicon to the revolving mould before pouring the metal, the chill has been entirely eliminated. The combination of the Mairy with the de Lavaud process has resulted in the production of a pipe, which, whilst it possesses all the initial high tensile strength of the original de Lavaud, has a substantially increased ductility.

The spinners, of which there are six, are arranged in line, in close proximity to the cupolas. Each spinner is driven by a 40-h.p. Crompton-Parkinson motor, variable speed 1,000 to 1,500 r.p.m., through a David Brown reduction-gear box. The motors are controlled by Brookhirst control panels, which are arranged in two banks of three each.

Each pair of machines is served by a roller-transfer conveyor, supplied by Bagshawe & Company, Limited, of Dunstable. The length of these transfers is proportional to give no more than clearance for the longest pipes before delivering them to the gantry, which is set at right angles to the spinners and serves the normalising furnace, the pipes passing over a weighbridge before entering the furnace.

The Normalising Furnace

All pipes are passed through the normalising furnace. Built by Priest Furnaces, Limited, of Middlesbrough, the furnace is of the most modern design, incorporating all the necessary features required to give uniformity of heat application and correct time cycles for preheating, soaking and cooling of pipes in order to ensure a continuous supply at the rate of 10 tons per hr.

The furnace is fired with raw producer gas, and is of the counterflow type. Special burner ports are arranged across the full width of the furnace, the gas and air being pre-mixed before being admitted into the heating chamber. This arrangement gives perfect uniformity of heat over the full length of the pipes, at the same time eliminating scale formation and giving maximum fuel economy. The pipes are conveyed through the furnace by means of a chain conveyor with heat-resisting steel fingers. The driving gear has been specially designed to give a very full range of speeds.

Gas is supplied from a number of small Priest producers. A feature of these producers is that they are fitted with a special type of rotary grate, which facilitates ashing and gives a perfect uniformity of blast distribution over the full bed of the fuel. This results in a steady yield of a uniform quality of gas of high calorific value. As a matter of fact, this last approximates 180 B.T.U.

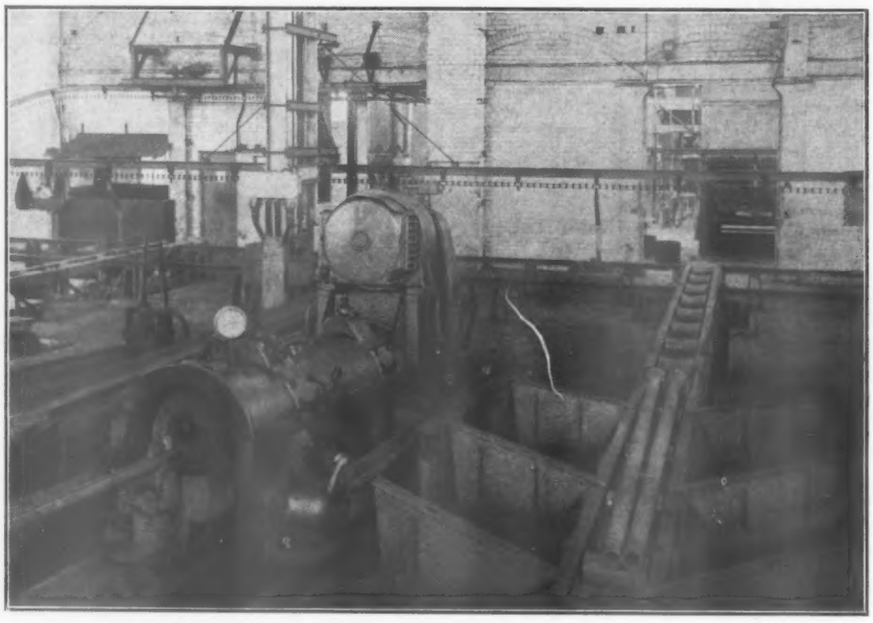
The producers are blown by a low-pressure fan, the necessary steam for saturation being obtained from a waste-heat boiler installed in conjunction with the normalising furnace. The waste gases are fan-exhausted from the furnace, through the waste-heat boiler, and are thence passed to the chimney at a relatively low temperature.

At the end of the casting shop a floor is laid out for the complete assembly of spare machines, which, when assembled, can be put into immediate commission, a simple enough expedient, which, however, is conducive to the highest efficiency, as it eliminates holding up the casting machine.

The pipes, on leaving the furnace, pass to the fettling gantries, though, so far as the body of the pipe is concerned, very little fettling is necessary. Three scrubbing machines are installed, and the scrubbing head is passed through

GENERAL VIEW OF THE PIPE-SPINNING MACHINES AT THE NUTBROOK WORKS.

CASTING LADLE IS TILTED AND A REGULAR STREAM OF METAL FLOWS INTO THE REVOLVING STEEL MOULD.



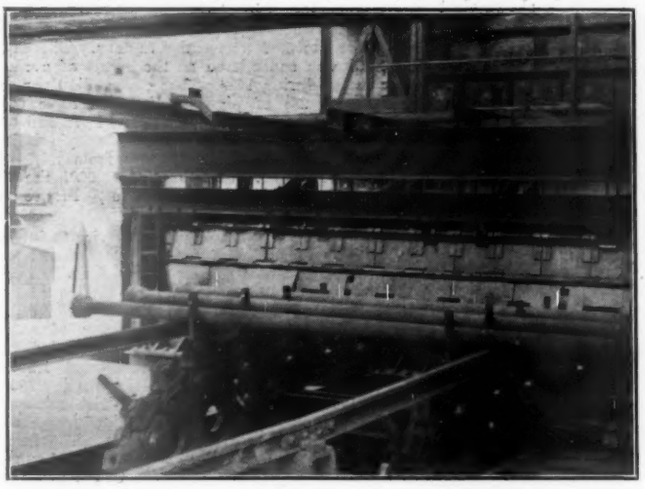
POSITION OF THE PIPE-MAKING MACHINE AT THE END OF THE CAST; THE PIPE ROLLS DOWN THE INCLINE ON TO THE CONVEYOR.

the pipe to remove loose sand and scale. Beyond the scrubbers the pipes are rotated for the grinding of the socket and spigot ends.

An electric transfer car takes the pipes from the fettling shop to the inspection gantries, where also the hydraulic pumps are installed for testing. It is worthy of note that all pipes are tested at 500 lbs. per sq. in. pressure, water being taken from the works system at this pressure; the standard test varies from 200 to 300 lbs. per sq. in.

After testing, the pipes are again weighed before loading on to a transfer car for delivery to the gantry serving the dipping tanks. The socket cores are made in a separate shop. Metal core-boxes are used, and the sand is fed from a mechanical sand-mixing plant, by way of shutes direct to the moulding machines, which are of the hand-operated jolt type. The core stove is of the continuous type, heated by hot air from a coke-fired furnace, a core passing through the oven in about 2 hrs.

The mass production of spun pipes is, of course, a distinct innovation, but so carefully were the details considered that from the very outset the works have run with the smoothness of a well-designed machine. This will be appreciated when it is stated that the present output is from 17,000 to 18,000 3-in. dia. pipes per week of five days, and the economies resultant from the concentration of the works on a standard production must be very considerable.



PIPES LEAVING THE NORMALISING FURNACE.

AN ELECTRIC CONVEYOR DELIVERING THE PIPES ON TO GANTRIES, IN READINESS FOR THE DIPPING OPERATION.

Stanton "New" Spun-Iron Pipes

At their foundries, the company continue to make pipes cast vertically in dry sand, and specials of all descriptions. On the Stanton concrete plant are produced Stanton concrete pipes for sewage mains, and for the conveyance of water under moderate pressures. This plant is also used to provide Stanton "New" spun-iron pipes, with a thin lining of concrete, which prevents the tuberculation caused by soft or peaty waters. In addition to concrete pipes, the company also manufacture other concrete products, such as lamp standards, manholes, paving-flags, kerbs, tiles and fence-posts.

Flexible Pipe Joints

Realising that the heavy vibration set up by modern traffic has in many districts become a serious menace to rigidly jointed mains, the Stanton Company turned their attention a few years ago to the design of joints which could be deflected under pressure without leakage. The two pipe joints which were introduced as a result of these investigations met with quick success, and are now firmly established as leading products in their respective spheres.

The Stanton-Wilson self-adjusting joint for spun-iron pipes is now used in over 1,300 miles of mains. Over 450,000 joints have been sold, and approximately two-thirds of this total represents repeat orders. This joint is especially popular in the coalfields of the North Midlands, as it enables mains to adjust themselves to subsoil movements caused by undermining. Owing to its absolute leak-tightness, which is unaffected either by deflection or by variations of pressure within the main, the joint is particularly suitable for high-pressure gas mains.

The joint can be assembled by unskilled labour under the most adverse conditions, and in a fraction of the time required to make a lead joint. Owing to the saving in labour costs, the finished Stanton-Wilson joint costs no more than an ordinary lead joint. The Ministry of Health grant a full thirty years' loan period with this joint.

Similar advantages, including flexibility, ease of assembly and leak-tightness under pressure, can be secured for concrete mains by the use of the Stanton-Cornelius flexible joint for concrete pipes. This joint has recently been adapted to the company's "special" 3-in. and 4-in. dia. "New" spun-iron pipes, thus enabling the advantages of flexibly-jointed cast-iron mains to be secured at a very low cost.

Mechanical Lead Joints

The experience of many years has proved lead to be a permanent and reliable material for the jointing of cast-iron pipes. The Stanton mechanical lead joint is a perfected form of lead joint, intended to replace the caulked or turned-and-bored joint under conditions which do not call for flexibility. It can be made by unskilled workmen, without special tools, and effects a considerable saving in time and labour. The jointing material takes the form of a precast lead ring, which is positively held in position and cannnot be dislodged. Although the joint is not resilient, it allows for angular distortion and "draw" of the spigot.

Continuous Casting Plant at the Holwell Works

At their Holwell Works, near Melton Mowbray, the Stanton Company have laid out one of the most up-to-date mechanised foundries in the United Kingdom. Here are produced Stanton standard cast-iron special pipes, which can be obtained in a range of dimensions wide enough to meet all ordinary requirements. Modern foundry methods are also used in the manufacture of cast-iron drain pipes, which are made and stocked in all standard types and sizes. The quality of these castings represents a considerable improvement on that of pipes produced by older methods.

Cast-Iron Tunnel Segments

In addition to cast-iron pipes and "specials," the Stanton Company also manufacture general castings of all types. One of the most important contracts which they have executed within recent years was for the supply of the 82,000 tons of cast-iron segments used to line the Mersey Tunnel. These segments were of an unusually large size in view of the fact that the 44-ft. dia. tunnel is the largest of its kind yet constructed.

The Stanton Iron Road

The Stanton Company also furnished the 4,600 tons of Stanton "Hard-Stud" road setts which form a 3-mile stretch of cast-iron highway throughout the Mersey Tunnel. A few years ago the Stanton iron road was introduced by the company in order to provide a permanent surface which would not deteriorate under the heavy industrial traffic of to-day. The initial success of this product has now been firmly consolidated by the success of the Mersey Tunnel highway. The Stanton iron road is particularly suitable for such points as bus-stops, docks, wharves, railway platforms and loading platforms of all types. For indoor use in garages, factories, dairies, bakeries, etc., the company have designed a lighter type of section which can be used to build up a permanent acid-resisting surface known as the Stanton iron floor.

Stanton Pig-Irons

The Stanton Company produce more foundry pig-iron for sale than any other firm in Great Britain. The three brands of Stanton pig-iron —Stanton, Holwell and Rixon's (W'bro')—are used throughout the foundry industry for every type of casting. Stanton irons are largely used for engineering castings; Holwell irons are extensively used for vitreous enamelled products; and Rixon's (W'bro') irons are used for thin-wall castings, such as rainwater pipes. For high-quality castings of exceptional strength, Stanton-Dale refined pig-iron is available.

Other Materials and Products

All qualities of limestone, including best white for sugar beet factories, and lump for road foundation work and rockeries, are supplied by the company. Lime is also supplied to a wide range of industries. The company supply sand for moulding, building and brickmaking. They also manufacture bricks of many grades, including rustic and facing bricks.

Transport

The recent development of the Stanton road-transport service has been of great assistance to users of cast and spun-iron pipes, who are

able to have the pipes delivered direct to the site alongside the trench in which they are to be laid. Rapid delivery is further expedited by the large stocks of pipes and specials which are kept at the company's warehouses in various parts of the country.

Stanton Concrete Pipes

By means of a centrifugal process, it is possible to produce concrete pipes of a considerably greater strength than those manufactured by vibratory or tamping processes. The materials used in the manufacture of these pipes are best British Portland Cement, properly graded Leicestershire granite and cleanwashed sharp sand. All materials, after being sampled and tested, are stored in damp-proof concrete bunkers, and the concrete is subjected to a daily test to ensure the maintenance of high quality. Before use, the materials are charted to comply with the maximum density curve.

Spinning

The wet concrete is introduced into a revolving mould, against the sides of which it is held and compressed by centrifugal force. The temperature of the water used for mixing is not allowed to fall below 60 deg. Fah., so that the concrete will not be adversely affected during cold weather. During the spinning operation, the hardest and richest concrete automatically collects on the inside of the pipes, where the greatest attrition occurs. The centrifugal action also has the effect of expelling the surplus water to the inside of the pipe, thus producing a high-strength non-porous concrete free from voids. After manufacture, the pipes are carefully matured in stockyards, so that their structure will not be adversely affected by changes in atmospheric conditions.

American Notes

Though the proposal for Federal control of scrap iron exports has been rejected by the Administration, a Senate group will hold public hearings on the matter of conserving this commodity. Evidence will be taken from both large, integrated steelmakers and the small independents. It should be noted that the independents have been clamouring that Japanese and European purchases not only have boomed scrap iron prices, but made a "corner" or a domestic scrap iron famine possible. The Secretary of State, Mr. Hull, in upholding unrestricted scrap iron exports, stated that he was "opposed to artificial trade barriers as running counter to the reciprocal trade programme and the good neighbour policy."

* * *

Mr. Eugene G. Grace, retiring President of the American Iron and Steel Institute, named the labour question the "outstanding problem of the day." He stressed that present difficulties were due to "outside" agitation. "Significantly the problem does not arise within the industry itself," he said. "The relations between management and employees in basic American industries are and have been healthy. The pressure is coming from the outside. The employee is in between various factions seeking in one way or another to gain control and to exploit him." Mr. Grace's comments were keenly followed, inasmuch as the Bethlehem Steel Corporation, which he heads, is the largest independent unit which has not signed an agreement with the Committee for Industrial Organisation.

* * *

The new President of the Institute, Mr. T. M. Girdler, of the Republic Steel Corporation, is also distinctly adverse to the C.I.O. unionisation plan.

* * *

While the American Iron and Steel Institute refused to comment on rumours of dissension in

(*Continued at foot of next column.*)

The Loughborough College

The system of training at this college is unique as far as England is concerned in that it is based on "training on production"; that is to say, students of the college not only receive theoretical instruction but practical training on productive work in the various workshops. The advantages claimed by a student are that his knowledge of theoretical engineering goes hand in hand with his practical training, so that at the end of his five year course he leaves having reached degree standard on the theoretical side, and having served an apprenticeship embracing all branches of engineering.

In the foundry all the castings, both ferrous and non-ferrous, required by the other departments are manufactured. Castings up to three tons in weight are made, and they include parts of engines, condensers, dynamos, motors, pumps, etc. The work is carried out entirely by students under skilled instruction, and an examination of the castings produced undoubtedly shows that they are well up to the standards of modern requirements.

In the case of the workshops of the college great care is taken to see that students go "round the shops" in a logical manner; for example, no student is allowed in the pattern shop until he has served about six months in the foundry. This is contrary to the procedure in certain other training centres, but it is realised that it is impossible for a young man to make a satisfactory pattern unless he is familiar with foundry work. Similarly in other departments, a student would not be allowed in the milling and gear-cutting shop unless he had previously been in a machine shop; neither would he be allowed in the automatic shop until he had been in numerous other shops. Finally, after having passed through all the various workshops, students are drafted to the drawing office.

The foundry is equipped with modern plant, and continual efforts are made to keep it up to date. The plant includes:—Five ton "Whiting" cupola, complete with charging platform; one ton "Whiting" tilting cupola; Sklenar oil-fired reverberatory furnace for melting non-ferrous metals, complete with all accessories; 200 lbs. "Morgan" oil-fired tilting crucible furnace; high-pressure air blast steel furnace; gas-fired "Wright" pit-type aluminium furnace; two "Carr" crucible furnaces for brass; melting pot for low temperature alloys; "Ajax" jolt-ram moulding machine with rapping, turn over, and drawing attachments; "Mumford" jolt-ram moulding machine; "Adaptable" and "Pridmore" moulding machines; Binder's International moulding machine; fettling bench with pneumatic exhauster; oscillating sand sifting machine; "Alfred Herbert" sand mixing machine; tumbling barrel; sand preparing plant; twin Norton grinder, and an "Ingersoll Rand" air compressor, with air receiver and supply pipes to all parts of the foundry, so that dusting nozzles, pneumatic rammers, drills, chipping hammers, plate rappers, etc., may be used when required.

A gantry, running the whole length of the shop, carries two Morris overhead cranes for transporting hot metal, castings, etc.

(*Continued from previous column.*)

the spirited contest preceding the election of Mr. Girdler as President, it is believed that whatever misunderstanding arose could be traced to the labour situation now confronting the industry.

* * *

The Troy Furnace Company, of Troy, New York, has placed in blast its furnace which has been idle since last autumn. The furnace is capable of turning out 550 to 600 tons of pig-iron per day, and the makers state that they will burden the furnace to its full capacity in order to fill orders promptly.

Statistics of the British Iron and Steel Industry

The British Iron and Steel Federation have just published, in advance of their usual Annual Year Book, due to appear in the autumn, the section covering the British iron and steel industry, including 55 tables. In answer to general demand, the initial publication is now made as soon as the production figures have been analysed. They represent returns made as to 100 per cent. of the iron and steel industry.

Owing largely to the expansion of completely integrated plants combining blast furnaces and steelworks, steelmakers' consumption of their own pig-iron and scrap metal increased from 51.6 per cent. to 53.2 per cent. (comparing 1935 and 1936), and the use of pig-iron and scrap bought from outside firms declined correspondingly. In total, "internal" consumption of steel-making materials rose by 1,225,000 tons, and outside purchases increased by only 778,000 tons.

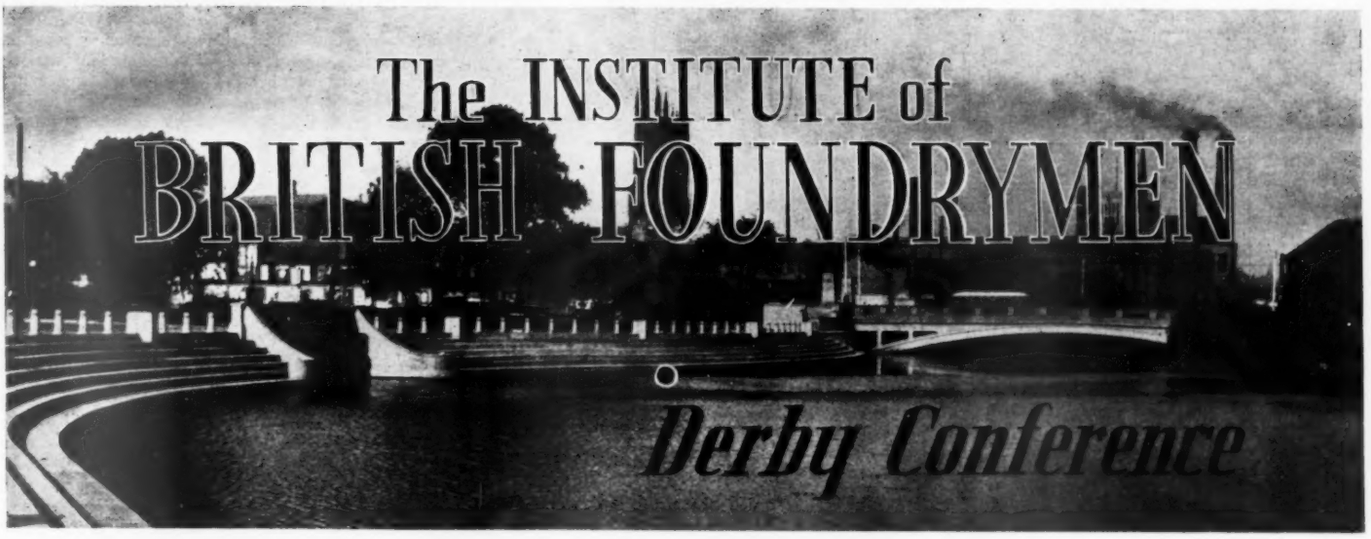
An important change took place during 1936 in the proportion of pig-iron to scrap in the open-hearth charge as a result of the increasing scarcity of steel scrap from mid-summer onwards. In 1935, the average 10-ton ingot contained 5.92 tons of scrap and 4.66 tons of pig-iron. In 1936 these proportions had altered to 5.87 tons and 4.72 tons. The change indicated was engendered as the result of a rise in scrap prices during 1936 of the order of 10 per cent. The greater use of pig-iron displaced some 60,000 tons of scrap, which would otherwise have had to be imported. As things were, the industry's bill for imported scrap alone in 1936 rose from £1,061,000 to £3,074,000, an increase of £2,013,000, the bulk being paid to the United States, France and Belgium.

Increased pig-iron production gave rise to interesting economies in blast-furnace performance, but caused serious problems as to coke and iron-ore supplies. Only 55.81 cwts. of burden, against 56.33 cwts. in 1935, were required per ton of pig-iron. High freights and the difficulty of quickly securing foreign supplies led to an increased demand for domestic iron ore. The additional 1,297,000 tons of pig-iron smelted in 1936 required 2,786,000 more tons of ore. Of this need British mines and quarries satisfied roughly 1½ million tons, while about a million tons came from abroad. In this connection it is interesting to note that supplies from Newfoundland, the Labrador Coast, and Sierra Leone have tripled in the last two years alone. Deposits in these countries are believed to be capable of considerable further development. In this country, rapid expansion is taking place in the Oxfordshire and Northants fields. Of the higher output during 1936, these districts contributed nearly half. At the same time, the comparatively low iron content of those ores necessitated a higher consumption of coke in the blast furnace and tended to aggravate the coke shortage. The output of hematite ore in Cumberland in 1936 increased to 750,000 tons, compared with 708,600 tons in the previous year.

Output of Pig-Iron, Steel and Finished Products

The British Iron and Steel Federation, in its Statistical Bulletin for April, 1937, reports that the production of pig-iron and ferro-alloys in the United Kingdom in April amounted to 680,700 tons, compared with 680,300 tons in March and 629,800 tons in April, 1936. The total for the first four months of the year is 7 per cent. greater than for the corresponding period of 1936. Steel ingots and castings production in April amounted to 1,080,400 tons, compared with 1,109,500 tons in March and 984,200 tons in April, 1936. The total for the first four months of the year is 9.7 per cent. greater than for the corresponding period of 1936.

THE ANNUAL MEETING of the Birmingham Metallurgical Society was held recently, when the Council reported the election of Mr. J. A. A. Fraser as President, and Messrs. A. L. Molineux, C. H. H. Franklin, W. C. Freeman and A. Pinkerton as Vice-Presidents for the ensuing year.



ANNUAL GENERAL MEETING

The annual meeting of the Institute was held in the Assembly Rooms, Market Place, Derby, on Tuesday, June 8, with the retiring President, Mr. H. Winterton, in the chair.

On the motion of Mr. W. T. Evans, seconded by Dr. A. B. Everest, the minutes of the annual general meeting held in Glasgow on June 9, 1936, were taken as read, approved, and signed by the President.

The Annual Report of the Council for the session 1936-37 was then presented.

ANNUAL REPORT

This report covers the period May 1, 1936, to April 30, 1937, and the accounts are for the year ended December 31, 1936.

The number of members on April 30 was 2,065, which constitutes a record, the previous largest number, 1,919, being recorded in 1932. A year ago the membership was 1,892; the present figures therefore show a net increase of 173 in the past twelve months. Table I shows the changes in membership which have taken place during the year, and an analysis of the present membership is given in Table II, the figures for the previous year being given in brackets as a comparison.

Deaths

The Council regrets to report the deaths of 18 members, including some who had been most active in the work of the Institute and who were widely known throughout the industry. Among these are:—

Mr. Emile Ramas, Past-President of the Association Technique de Fonderie de France, and Honorary Member of this Institute.

Mr. John Haigh, of Wakefield, Past-President of the Lancashire Branch, and for many years a member of the Council of the Institute.

Mr. J. E. Cox, of Ilkeston, a prominent member of the East Midlands Branch.

Mr. Sidney Evans, a member of the London Branch, who was widely known throughout the industry in this country and on the Continent.

Mr. Ian S. Osborn, of Sheffield, who died at the early age of 36.

Mr. W. Moscrip, of Leven, Fife, a well-known member of the steel foundry trade, who, together with Mrs. Moscrip, took part in the visit to the recent Düsseldorf Congress and Exhibition.

Mr. T. E. Bashford, a founder and for several years treasurer of the Middlesbrough Branch.

Mr. J. M. Weir, of South Shields.

Mr. D. Dalrymple, a Past-President of the Birmingham Branch.

Mr. Harry Pemberton, of Derby, who joined the Institute over thirty years ago and was a Past-President of the East Midlands Branch.

Honours Conferred Upon Members

Among the honours which have been conferred upon members are the following:—

Sir Robert Hadfield, Bart., has been raised to the distinction of Commander of the Legion of Honour, and has been appointed an

MR. C. W. BIGG
(*President of the Institute*).

Honorary Member of the Institution of Civil Engineers.

Mr. J. Léonard, President of the Association Technique de Fonderie de Belgique, and Honorary Member of this Institute, was decorated by H.M. the King of the Belgians with the Cross of Chevalier of the Order of Leopold, on the occasion of the International Foundry Congress in Brussels, in September, 1935.

Mr. Vincent Delport has been elected President of the International Committee of Foundry Technical Associations.

Mr. W. J. Rees has been re-elected President of the Refractories Association of Great Britain.

Mr. A. C. Turner has been elected President of the Foundry Trades' Equipment and Supplies Association.

Finances

Referring to the income and expenditure account, the Report states that, due to increased subscriptions the income was slightly higher than in 1935. This increase of income has been practically neutralised by certain small increases in expenditure mainly in Branch expenditure, necessitated by increased membership and activities. The excess of income over expenditure for the year was £168 0s. 2d., compared with £166 18s. 4d., at the end of 1935. The finances of the Institute are in a sound condition, but as the numerous activities of the Institute are carried on almost entirely from the income derived from subscriptions, the most careful economy is necessary in order that this sound condition shall be maintained.

E. J. Fox Gold Medal

At the annual general meeting in June, 1936, the retiring President, Mr. J. E. Hurst, announced that Mr. E. J. Fox, managing director of the Stanton Ironworks Company, Limited, had presented the sum of £500 for the establishment of a Gold Medal to commemorate the development of the centrifugal casting process in this country. The medal was to be presented to the individual who had contributed in some outstanding way to the progress of the foundry industry, with particular reference to foundry metallurgy. Mr. Fox considered that the active association of Mr. J. E. Hurst, with the development of the centrifugal casting process, was a fitting opportunity to make this gift.

The Council gratefully accepted the munificent gift of Mr. Fox, and decided that the medal should be known as the E. J. Fox Gold Medal. It is intended that it should be awarded by the Council on the recommendation of two assessors, whose decision as to a suitable candidate might be made in collaboration with the President of the Institute. Sir W. J. Larke, K.B.E., and Sir Harold Carpenter, F.R.S., accepted the invitation to act as assessors for a period of three years.

On the recommendation of the assessors the Council decided to make the first award of the medal to Prof. Emeritus Thomas Turner, M.Sc.

Badge for Use by Vice-Presidents

The Council gratefully acknowledges the gift of a gold badge for the use of the Junior Vice-President.

Awards

Oliver Stubbs Medal.—The Council decided to make two awards of the Oliver Stubbs Medal in the year 1936, as follows:—

Mr. F. Hudson, "for the work he has done in promoting scientific foundry practice, and particularly his investigation work with relation to moulding sands, most of which has been made known to the Institute through the various Papers that he has presented from time to time."

Mr. E. Longden, "in recognition of the many valuable Papers on foundry practice, particularly in connection with the shrinkage of castings, which have been presented to the Institute over a number of years."

Meritorious Services Medal.—The fourth award of the Meritorious Services Medal was made in June, 1936, to Mr. James Smith, President of the Newcastle Branch, "for his continuous efforts to promote the development of the Institute since he became a member in 1905."

Diplomas.—The announcement of the award of Diplomas for the year 1936 was made at the Glasgow Conference, in June, 1936. The names of the recipients and the Branches before which their Papers were given, are as follow:—

G. L. Harbach, Birmingham Branch.
A. Phillips, Burnley Section of the Lancashire Branch.
J. McGrandle, Scottish Branch.

Buchanan Medals and Prizes.—The Buchanan Medals and Prizes are awarded on the results of the examinations in foundry practice and patternmaking held by the City and Guilds of London Institute. The names of the recipients are given late in this report in the section headed "Educational Work."

John Wilkinson Medal.—This Medal is awarded annually to a member of the Lancashire Branch Junior Section, on the results of an examination. The winner in 1936 was Mr. James Holden.

Branch Activities

Membership of the Branches and attendance at Branch meetings and other functions, is one of the few contacts with the Institute made by a large proportion of the members.

In spite of the increasing amount of work of a national character now being undertaken, the Council recognises that the work of the Branches is of fundamental importance. There are now ten Branches, together with five Sections of Branches, including two Sections which have been formed during the past year, namely: East Anglian Section of the London Branch, and the Bristol Section of the Wales and Monmouth Branch. The former has had a most successful session and caters for the increasing number of foundrymen resident in the Eastern Counties, while the latter, which was formed in October last, fills a long-felt requirement for regular meetings of the Institute in the West of England.

The Council expresses its thanks to the Branch-Presidents, secretaries, and other officials; to the authors of Papers; and to the directors and staffs of the various works which have been visited.

A two-days' meeting of the London and Birmingham Branches was held in London, in October, and was a very successful gathering.

South African Branch

It is with great pleasure that the Council records that as a result of the active efforts of the honorary corresponding member for South Africa, Mr. A. H. Moore, and of the efforts of Mr. A. H. Guy, following on his visit to this country in 1936, a Branch of the Institute has been formed in South Africa, with headquarters at Johannesburg. In addition to the 11 members already in that country, 40 new members have been enrolled, making a total initial membership of 51.

TABLE I.—*Changes of Membership*, 1936-37.

	Subscribing firms.	Members.	Associate members.	Associates.	Associate students.	Total.
At April 30, 1936	49	778	926	120	19	1,892
Additions and transfers from other grades	18	132	150	11	8	319
	67	910	1,076	131	27	2,211
Losses and transfers to other grades	1	46	89	10	0	146
At April 30, 1937	66	864	987	121	27	2,065

MR. J. HEPWORTH, M.P., J.P.
(Senior Vice-President of the Institute).

The President is Mr. T. Nimmo Dewar, managing director of the United Steel Corporation of South Africa, Limited. The first meeting of the Branch was held on March 10, 1937.

Board of Development

The Board of Development was formed in the autumn of 1935. After numerous meetings and considerable correspondence, a report recommending extensive changes in the Institute's publications was submitted to the Council and considered by the Branch Councils. The Board has since put forward a more comprehensive report containing several recommendations, the adoption of which, it is hoped, will materially increase the prestige of the Institute and its value to the members and to the trade in general. An Organisation Committee is now working out the details of these recommendations, and they will be submitted to the Council for further consideration in due course.

Kindred Institutions

At the invitation of the Iron and Steel Institute, a joint meeting with that Institute was held in London, on October 30, 1936, under the chairmanship of the President of the Institute of British Foundrymen. At this meeting, the Second Report of the Steel Castings Research Committee of the Iron and Steel Institute was presented and discussed.

Official support was accorded to the Congress of the International Association for Testing Materials, held in London from April 19 to 24, the President, Dr. A. B. Everest and the secretary representing the Institute at various meetings and functions in connection with the Congress.

The Institute has also co-operated with a number of similar institutions in establishing a Joint Committee on Materials and their Testing, for the promotion of the study of these subjects in Great Britain.

In addition to the foregoing, the close relations which have been established with other institutions have been maintained and strengthened, and many of the Branches have held joint meetings with the corresponding local Branches of other national bodies.

International Relations

The friendly relations with foundry technical societies in other countries have been maintained through the medium of the International Committee of Foundry Technical Associations. Over forty members and ladies attended the International Foundry Conference and Exhibition held at Düsseldorf in September, the British party being under the leadership of the President of the Institute. Those who were present are indebted to the organisers of the Congress, The Technischer Hauptausschuss für Giessereiwesen; to Mr. W. Bannenberg, its President, and to Dr. Geilenkirchen, its director, for their cordial reception and their hospitality. A meeting of the International Committee of Foundry Technical Associations was held at Düsseldorf during the Congress, at which the Institute was represented by the President, and Mr. V. C. Faulkner and the secretary, who attended as the secretary of the Committee.

Arrangements are being made to participate in the next Foundry Conference, which will be held in Paris from June 18 to 24. This Conference will be of particular interest to members, as Mr. V. Delport, now President of the International Committee, will be the chief representative of all the foreign Foundry Associations at the various meetings and functions.

TABLE II.—*Analysis of Membership, April* 30, 1937.

Branch.	Subscribing firms.	Members.	Associate members.	Associates.	Associates (students).	Total.
Birmingham	7 (3)	135 (121)	144 (124)	16 (16)	5 (4)	307 (268)
East Midlands	3 (3)	55 (49)	89 (82)	4 (5)	—	151 (139)
Lancashire	14 (14)	109 (111)	200 (213)	25 (31)	—	348 (369)
London	8 (6)	182 (171)	106 (97)	6 (6)	— (1)	302 (281)
Middlesbrough	1 (—)	24 (20)	33 (34)	6 (5)	6 (—)	70 (59)
Newcastle	7 (7)	32 (31)	30 (30)	47 (44)	10 (9)	126 (121)
Scottish	6 (4)	101 (95)	187 (183)	9 (8)	1 (1)	304 (291)
Sheffield	7 (6)	93 (82)	59 (57)	2 (3)	1 (1)	162 (149)
South African	8 (—)	27 (—)	14 (—)	2 (—)	—	51 (—)
Wales and Mon.	2 (2)	43 (32)	45 (33)	—	3 (3)	93 (70)
W.R. of Yorks	3 (3)	40 (43)	69 (62)	4 (2)	1 (—)	117 (110)
Unattached	— (1)	23 (23)	11 (11)	—	—	34 (35)
	66 (49)	864 (778)	987 (926)	121 (120)	27 (19)	2,065 (1,892)

The authors of Exchange Papers presented on behalf of the Institute to overseas conferences were as follow:—

American Foundrymen's Association Convention, 1936, at Detroit—Mr. J. E. Hurst.

Conference of the Association Technique de Fonderie, Lille—Mr. G. L. Harbach.

International Foundry Conference, Düsseldorf—Mr. J. G. Pearce.

The authors of Exchange Papers at forthcoming conferences will be:—

American Foundrymen's Association Convention, 1937, at Milwaukee.—Mr. J. Roxburgh.

International Foundry Conference, Paris—Mr. H. H. Shepherd.

Additional Papers by Mr. J. E. Hurst and Dr. A. B. Everest will be given respectively to the American and International Foundry Congresses.

Papers were presented at the Glasgow Conference of this Institute on behalf of the American, French and German Foundry Associations, and all these Associations will present Papers at the forthcoming Conference to be held at Derby.

Foundry Exhibition

The Council has accepted an invitation on behalf of the Institute to visit the Foundry Exhibition to be held in conjunction with the Engineering and Marine Exhibition at Olympia in September next, and has also accepted an invitation from F. W. Bridges & Sons, Limited, the organisers, to organise a stand at this exhibition. This stand will be used mainly as a rallying point for foundrymen.

Educational Work

The educational work which has been described in detail in previous reports has continued successfully throughout the year. Examinations in patternmaking and in foundry practice and science carried out by the City and Guilds of London Institute in collaboration with the Institute of British Foundrymen, were held in May, 1936, and the results are as follow:—

	No. of candidates.	Pass 1st class.	Pass 2nd class.	Percentage of passes.
Patternmaking—				
Intermediate grade	35	8	13	60.1
Patternmaking—				
Final grade ..	19	5	9	73.7
Foundry practice and science	61	13	20	54.2

Prizes were awarded to:—

PATTERNMAKING—INTERMEDIATE GRADE.

Mr. F. N. Rand, of Constantine Technical College, Middlesbrough, Bronze Medal of the C. & G. of London Institute.

PATTERNMAKING—FINAL GRADE.

Mr. L. M. Abrahams, of L.C.C. School of Engineering and Navigation, Poplar, Silver Medal of the C. & G. of London Institute and Buchanan Prize of the Institute of British Foundrymen.

Mr. W. Brindley, of Wolverhampton and Staffordshire Technical College, Buchanan Prize of the Institute of British Foundrymen.

FOUNDRY PRACTICE AND SCIENCE.

Mr. V. G. Ellis, of Coventry Technical College, Silver Medal of the C. & G. of London Institute, and Buchanan Prize of the Institute of British Foundrymen.

Mr. A. J. Wilson, of Sir John Cass Technical Institute, London, Buchanan Silver Medal of the Institute of British Foundrymen.

Mr. G. M. Andrew, of Sheffield Foundry Trades Technical Society, Buchanan Prize.

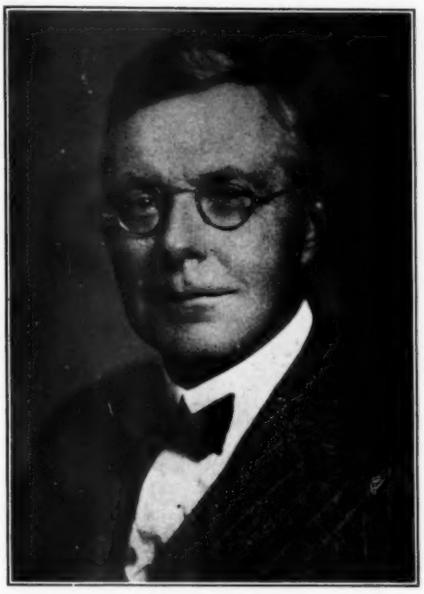
Mr. G. F. Taylor, of Constantine Technical College, Middlesbrough, Buchanan Prize.

The certificates awarded to the candidates who passed the examination have been endorsed by the President of the Institute, who has also endorsed six certificates gained by candidates successful in passing the examination (moulders' course) of the Union of Lancashire and Cheshire Institutes.

National Certificates in Mechanical Engineering.—These certificates are issued by the Board of Education and the Institution of Mechanical Engineers, and six certificates were endorsed by the President of this Institute in respect of special foundry subjects.

The degree course in foundry metallurgy at the University of Sheffield, has now been in existence for nearly three years; the number of students who have enrolled this year represents an increase on those enrolled during the first two years of the course, and the course is making satisfactory progress.

In addition to the foregoing activities, the Council wishes to emphasise the value of the work done by the British Foundry School at Birmingham, which was established through the efforts of the British Cast Iron Research Association and of Mr. J. G. Pearce. The school provides a specialised course of one year's duration, for men who are already in the industry and who wish to equip themselves for more important technical work.



MR. W. B. LAKE, J.P.
(*Junior Vice-President*).

Annual Conference, Glasgow, 1936

The Thirty-Third Annual Conference was held at Glasgow and Edinburgh, from June 9 to 12, 1936, and the attendance was one of the largest of a long and successful series. Members and ladies were entertained at a reception at the City Chambers on Tuesday, June 9, by the Rt. Hon. the Lord Provost of Glasgow.

At the opening meeting on June 10, members were welcomed by the Rt. Hon. Lord Provost; Sir James Lithgow, Bt., President of the Reception Committee; Col. Norman Kennedy, President of the Glasgow Chamber of Commerce; and Sir Arthur Huddleston, director of the Royal Technical College.

Mr. H. Winterton was installed President in succession to Mr. J. E. Hurst, and Mr. C. W. Bigg and Mr. J. Hepworth, M.P., were elected respectively to the offices of Senior and Junior Vice-President.

On Thursday, June 11, the work of the Conference was removed to Edinburgh, the capital of Scotland, and following the session for the discussion of Papers in the morning at the Heriot-Watt College, the party was entertained at a reception at the City Chambers by the Lord Provost. Bailie Aldridge welcomed the visitors on behalf of the Corporation.

The thanks of the Institute are tendered to the Lord Provost of Glasgow; the Lord Provost of Edinburgh; the firms who arranged visits for members and ladies and to the staffs of those firms; to the authors of Papers; to the subscribers to the conference funds; and to all who assisted in the organisation and carrying out of the many duties connected with the arrangement of so large a gathering.

The Institute wishes particularly to record its appreciation of the work carried out and of the hospitality tendered by the Scottish Branch, and to express its congratulations to the Branch upon the success of the arrangements which were made. Congratulations and thanks are specially accorded to the President of the Branch, Mr. D. Sharpe; Mr. John Bell, conference secretary, whose perfect organisation won the admiration of all the visitors; and to Mr. A. Campion.

Edward Williams Lecture

The Second Edward Williams Lecture was delivered at the Glasgow Conference by Prof. A. L. Mellanby, D.Sc. The Third Lecture will be given at Derby on June 9, at the opening session of the Conference, by Dr. C. H. Desch, F.R.S.

British Cast Iron Research Association

The British Cast Iron Research Association continues actively to develop, and the year 1936-37 promises to be a record in income and activity. At the annual meeting in November, 1936, the Earl of Dudley was elected as the new President, with Lord Austin of Longbridge and Prof. Thomas Turner as new Vice-Presidents.

Mr. H. B. Weeks, chairman of the Council since the Association began, has been succeeded in that office by Dr. Harold Hartley, and Mr. J. T. Goodwin, M.B.E., has retired from his office as vice-chairman of the Council after twelve years in that capacity.

The Association has recently undertaken an important investigation, sponsored by the Institution of Mechanical Engineers, on high-duty cast irons for engineering purposes. It is proposed in this connection to investigate the mechanical properties of the whole range of cast irons suitable for engineering work.

Council

Four meetings of the Council and more than twenty meetings of standing and special Committees have been held during the year. The Council meetings were held at Glasgow, Birmingham, Bradford and Newcastle, and the average attendance was thirty-seven.

There have been four meetings of the Technical Committee, one meeting of the Technical Council and upwards of forty meetings of the Sub-Committees of the Technical Committee.

The Council of the Institute consists of:—

(*a*) *Ex-officio* members, *i.e.*, the President, Vice-Presidents, Past-Presidents, Branch Presidents and Branch secretaries.

(*b*) Members elected by the Branches.

(*c*) Members elected by ballot by the whole of the members.

The last named are ten in number, of whom five retire each year. The five who so retire at the Annual General Meeting on June 8 are:—

Prof. J. H. Andrew, Mr. V. Delport, Mr. E. Longden, Mr. P. A. Russell, and Mr. D. H. Wood.

All these gentlemen are eligible for re-election for a further period of two years and offer themselves for re-election.

The Council expresses its thanks to Mr. W. B. Lake, J.P., for his services as honorary treasurer and for his guidance in connection with finance; also to Mr. J. W. Gardom, Convener of the Tech-

nical Committee, for his leadership of the various activities of this Committee and of its Sub-Committees.

Annual Conference

The Thirty-Fourth Annual Conference will be held at Derby from June 8 to 11, when Mr. C. W. Bigg, President-elect, will be installed President.

H. WINTERTON,
President.

T. MAKEMSON,
Secretary.

Adoption of Report

The RETIRING PRESIDENT proposed the adoption of the General Council's Annual Report for the year ended April 30, 1937, which Report was taken as read.

MR. VICTOR STOBIE, M.I.E.E. (Past-President), who seconded, emphasised particularly the Institute's gratitude to Mr. E. J. Fox (managing director of the Stanton Ironworks Company, Limited) for his generosity in placing £500 at the disposal of the Institute for the establishment of a Gold Medal. The Annual Report was unanimously adopted, without discussion.

Accounts

MR. W. B. LAKE, J.P. (retiring hon. treasurer), presented the Accounts for the year ended December 31, 1936, and commented with satisfaction upon the figures, which reflected the increasing activity and the progressively improving financial stability of the Institute in the seven years during which he had served as hon. treasurer. Inasmuch as the occasion was the last on which Mr. Lake would appear before the meeting as hon. treasurer, he took the opportunity to thank his numerous friends in the industry for their many kindnesses to him during his period of office.

The resolution for the adoption of the Accounts was seconded by MR. J. E. HURST, and was carried unanimously without discussion.

Report of Technical Committee

MR. J. W. GARDOM (Convener of the Technical Committee) presented and proposed the adoption of the Committee's Annual Report. He took the opportunity to express his gratitude to all members of the Committee and Sub-Committees for their work, particularly having regard to the fact that in view of present-day industrial activity it was difficult for them to give the time necessary for the Committee's work. He was particularly pleased that the Costing Sub-Committee was presenting a report on "The Establishment of Costs in a Grey Iron Foundry" during the course of the Derby Conference.

MR. F. J. COOK, M.I.Mech.E. (Past-President), who seconded, paid a tribute to Mr. Gardom for his work as Convener of the Technical Committee. He added that the Committee had devoted a great deal of energy to the work and the Institute appreciated it to the full. The Report was unanimously adopted.

FIFTH ANNUAL GENERAL REPORT OF THE TECHNICAL COMMITTEE

The Technical Committee was formed in 1931, its objects being:—

(1) To establish an organisation to study, and keep the members of the Institute in touch with, technical progress in various branches of the industry.

(2) To fulfil a need which had been felt for some time of establishing an organisation through which the Institute could be represented on various national and international bodies concerned with the preparation of specifications and with technical development.

The organisation of the Committee is representative of the Branches of the Institute, and also of the various phases of the foundry industry. Each Branch elects two members annually, and these, together with certain *ex-officio* members, form the Technical Council which meets as and when required. Additionally, there are a large number of co-opted members of the various Committees, selected on account of their special knowledge of some branch of the industry, and these, together with the Technical Council, form the Technical Committee which meets four times per year.

The activities to which reference is made in paragraph (1), namely, the study of technical development within the industry, is carried out mainly by eight sub-committees which cover almost every phase of foundry practice. Each sub-committee meets at least four times a year, and more frequently if required. Details of the work of these sub-committees during the past twelve months are given in the Sub-Committee Reports at the end of this Report.

In addition to these reports, reference may here be made to certain outstanding work which has been accomplished during the past year.

(*a*) THE STEEL CASTINGS SUB-COMMITTEE made a joint contribution to the discussion on the Second Report of the Steel Castings Research Committee of the Iron and Steel Institute, presented at a joint meeting of that Institute and of the Institute of British Foundrymen.

MR. S. H. RUSSELL
(*Honorary Treasurer*).

(*b*) THE MALLEABLE IRON SUB-COMMITTEE, in collaboration with the Cast Iron Sub-Committee, has been engaged for some time on compiling data which show the necessity of specifying tolerances of dimensions in the production of castings. A report containing much of this data and certain recommendations was presented to the Conference at Glasgow in June, 1936, and has since been discussed by a number of Branches of the Institute.

(*c*) THE COSTING SUB-COMMITTEE for some three years has been engaged in studying the subject of foundry costs; sectional reports have been published from time to time, and these reports have been discussed by various Branches. A comprehensive report covering the whole subject and embodying suggestions made in the discussions by the Branches has now been prepared, and will be submitted to the Conference to be held at Derby in June, 1937.

(*d*) THE NON-FERROUS SUB-COMMITTEE, realising that a very large number of very similar specifications have been issued for certain non-ferrous alloys, has prepared draft specifications for two leaded gun metals, which it is hoped will cover a variety of requirements and thus replace a number of existing specifications. Before submitting these proposals to a standardising body, it was desired to have the criticism and advice of the members of the Institute generally, and with this end in view, these proposals were submitted to the Glasgow Conference in 1936, and have since been discussed by a number of Branches.

(*e*) THE REFRACTORIES SUB-COMMITTEE has prepared a tentative specification for Tests for Cupola Fire Bricks, upon which they also desire to have opinions and criticism before it is submitted to a standardising body. Certain members of the Institute have kindly agreed to work to this specification and communicate their views and experiences to the Committee in due course.

(*f*) THE CAST IRON SUB-COMMITTEE two years ago issued in conjunction with the British Cast Iron Research Association a booklet of Typical Microstructures of Cast Iron. During the past year, a second booklet of Typical Microstructures has been issued in collaboration with the same Association. The second series includes a number of typical microstructures of malleable cast iron.

The most important part of the work to which reference is made in paragraph (2) is carried out by the Technical Committee as a whole, additional to and in some cases in conjunction with the appropriate sub-committees, and consists of representation on standardising bodies, particularly on Committees of the British Standards Institution. The Institute, through the Technical Committee, is represented on the most important committees of this Institution concerned with the foundry industry, and an active part has been taken by the Technical Committee and the Cast Iron Sub-Committee in the preparation of the draft B.S.I. specification for High-Duty Cast Iron, and the revised B.S.I. specification No. 321-27, General Grey Iron Castings.

The Committee particularly acknowledges its indebtedness to Mr. P. A. Russell, Convener of the Cast Iron Sub-Committee, for his very active work in connection with these specifications. Copies of the drafts are now being considered by members of the appropriate sub-committees, who are invited to communicate their views on the draft specifications before they are adopted finally.

An International Committee consisting of representatives of foundry technical associations is actively engaged in studying the subject of testing cast iron, and Dr. A. B. Everest represents the Institute on this committee. A meeting of this committee was held in Düsseldorf in September, 1936, the Institute being represented by Mr. F. K. Neath and the Secretary.

Dr. Everest represented the Institute through the Technical Committee at the recent Congress of the International Association for Testing Materials held in London, and the President and other members of the Committee were present at most of the meetings of this Congress.

Representatives of the committee are collaborating with representatives of the Literary and Awards Committee in the preparation of an international dictionary of foundry terms, under the auspices of the International Committee of Foundry Technical Associations.

INQUIRY BUREAU. The Inquiry Bureau continues to give useful service to members who require specific information on foundry problems, or who require knowledge as to where certain information can be found.

NOMENCLATURE. The Committee is continuing to compile a list of standard definitions and terms which it is hoped will be published in due course.

The Technical Committee at present consists of over sixty members. The Convener wishes to acknowledge the indebtedness of the Institute to these members for their services, and he particularly wishes to thank the sub-committee conveners and secretaries for their work.

The thanks of the Institute are also tendered to the firms with whom the members are associated, for facilities which are given, and to those firms who have carried out tests and other work on behalf of the Committee.

J. W. GARDOM,
Convener, Technical Committee.

REPORTS OF SUB-COMMITTEES

Sub-Committee on Cast Iron

This Sub-Committee has been principally concerned with the proposals of the British Standards Institution for the revision of Specification 321 General Grey Iron Castings, and for the establishment of a new Specification for High-Duty Cast Iron. New size test-bars being incorporated in these Specifications, both of which have now reached the draft stage, and having been scrutinised by this Sub-Committee at all stages of their preparation, these drafts are approved by this Sub-Committee subject to a few minor alterations, particularly with regard to deflection values. A report embodying the main provisions of these Specifications has been circulated to all members of the Technical Committee, and this report or the full draft is available to any member of the Institute on application to the secretary.

The distribution of the second series of Typical Microstructures of Cast Iron has been carried out during the year, and the demand for these has been gratifying. Through the kindness of Mr. A. E. Peace, a complete series of lantern slides of both series of Typical Microstructures has been presented to the Institute, and is available on loan on application to the secretary of the Institute.

The Sub-Committee has continued its work in connection with the assembly of physical data for cast iron, with a view to the possibility of publishing a summarised list which should be of value to designers and users of castings.

The Sub-Committee is also engaged upon the collection of data on methods of running castings. In view of the wide field of this investigation, this work is proceeding slowly.

P. A. RUSSELL,
Convener.

Sub-Committee on Costing

Since its last report, the Costing Sub-Committee has held several meetings and discussed in correspondence various aspects of costing in a grey iron foundry, and, as a result, the entire subject has been covered and embodied in a report, the text of which was approved at a meeting of the Sub-Committee held in London on April 3. That report will be presented at the Derby Conference in June.

The main object of the Costing Sub-Committee has been achieved, but the question of issuing a simplified system for the smaller jobbing foundries is being considered, and an endeavour is being made to establish a form of cost sheet embodying the principles of the system and which could be adapted to various types of foundries.

The members of the Sub-Committee are prepared to remain on the Committee should it be decided to retain it in an advisory capacity with a view to giving advice to the industry on costing matters in so far as they relate to grey iron foundries.

V. DELPORT,
Convener.

Sub-Committee on Malleable Cast Iron

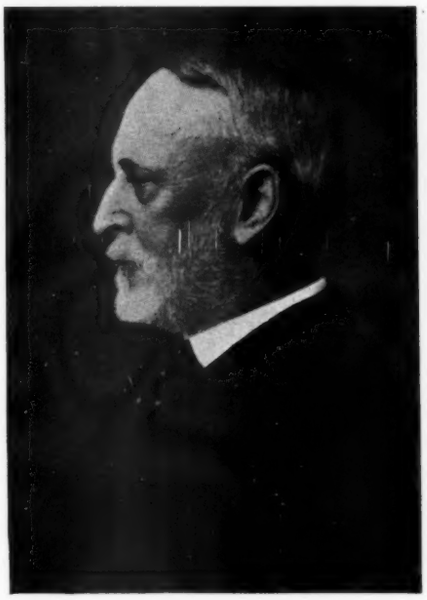
The work of the Sub-Committee on the subject of dimensional tolerances for castings was brought to a close early in the year, and the data were embodied in a report which was presented at the Glasgow Conference in June, 1936. This Paper has since been read to the majority of the Branches, and the committee are collecting the points raised in the discussions in the hope that more concrete recommendations for dimensional tolerances may be formulated.

The investigation on the practicability of using various-sized test-bars to represent a range of sections for malleable castings has shown considerable progress. The results of all the tests made have been collected and an attempt made to correlate the results with the varying sections. No final conclusions have yet been made on this subject, however, and it seems likely that further work will still have to be done before recommendations can be made for a revision of the B.S.I. Specification.

A. E. PEACE,
Convener.

Sub-Committee on Melting Furnaces

This Sub-Committee has for some time been engaged in the preparation of a report on foundry melting furnaces, with a view to providing data on modern melting practice. At the beginning of this year it was found that the scope of the report was too wide, and it was decided that in the first instance it should be limited to melting furnaces for grey cast iron.



PROF. T. TURNER, M.Sc.
(*First Recipient of the E. J. Fox Medal*).

The report will be divided into sections, each dealing with one type of furnace. Sections on the cupola, rotary furnaces and electric furnaces are now completed and further sections are in preparation.

L. W. BOLTON,
Convener.

Sub-Committee on Non-Ferrous Castings

The work of this Sub-Committee during 1936-37 has been mainly concerned with the consideration of criticisms raised on their report, "Recommendations for Two Leaded Gunmetals," presented at the 1936 Annual Conference of the Institute. The report has been presented during the session at a number of Branches and has provoked a certain amount of correspondence in the technical press. The reception accorded the report has been favourable and the Sub-Committee is encouraged to proceed with this work of preparing a suitable series of alloys for suggested standardisation. Further work of the same type on bronzes of higher lead content is in hand, and it is hoped that in due course similar recommendations for leaded phosphor bronzes can be put forward by the Sub-Committee.

G. L. BAILEY,
Secretary.

Sub-Committee on Refractories

The Sub-Committee has had several meetings during the year, and its recommendations for the specification and standard tests for cupola firebricks was finally approved by the Technical Committee at the meeting in Birmingham on March 6 for submission to the Institute members.

During the year the Sub-Committee has been further strengthened by the election of new members, and is at present actively engaged on investigating closely the characteristics of cupola ganister with a view to the preparation of a draft specification for submission to the Technical Committee. A great amount of useful investigation has been completed already, and it is hoped to be able to submit a considered report during the present year.

W. J. REES,
Convener.

Sub-Committee on Sands

The work of the sands questionnaire mentioned in the previous annual report has been completed. The tabulation and comments will be published later.

Recommended methods of dry sand testing are also ready for publication, and methods of sieve testing have been under consideration.

Sand testing equipment is being checked and resulting therefrom modifications to some existing equipment are recommended.

Much progress has been due to the co-operation of the Sub-Committee on Moulding Materials of the Iron and Steel Institute and the Sands and Refractories Committee of the British Cast Iron Research Association.

JOHN J. SHEEHAN,
Convener.

Sub-Committee on Steel Castings

Work has continued upon the three investigations detailed in the 1936 report:—

(*a*) Considerable data have been collected upon the effect of various heat-treatments on steels of normal compositions. A few further tests are required before the first tabulation can be completed.

In carrying out these tests it was found necessary to design a standard test block casting, and it is recommended that this should be used when bars are being prepared for investigating the properties of cast steels.

(*b*) All the valve castings under consideration are undergoing test by a well-known valve manufacturer, and all have successfully withstood the highest pressure tests. The castings are now being sectioned to ascertain heterogeneity, etc.

(*c*) Arrangements have been made with a refractories manufacturer to supply a uniform sand (to a specification agreed with the Iron and Steel Institute Steel Moulding Materials Committee and approved by the Sands Sub-Committee) for the making of special test castings. Some data have also been collected upon liquid steel temperatures in the foundry.

Difficulty is being experienced in deciding upon a suitable type of experimental casting for the making of tests, but trials of various forms continue.

A member of the Committee has prepared a very comprehensive bibliography upon the subject of steel castings defects, and this is available to any interested member.

C. H. KAIN,
Convener.

Second Congress of the International Association for Testing Materials

LONDON, APRIL 19 TO 26, 1937.

Dr. A. B. Everest represented the Institute officially at the technical sessions of this Congress, and a summary of his report, presented to the Technical Committee, is as follows:—

The Congress was divided into four main groups, dealing respectively with metals, inor-

ganic materials, organic materials, and finally, subjects of general interest. From the point of view of the Institute of British Foundrymen, Group A, dealing with metals, was undoubtedly the most important, sub-sections in this group dealing with the behaviour of metals dependent upon temperature and giving consideration to mechanical properties, especially creep and impact, at high temperatures, and also to oxidation and corrosion as affected by temperature. The second sub-section was devoted to progress of metallography and dealt essentially with the testing methods and the results of testing in the fields of microscopy, X-ray examination, electron interference, and so on. Some attention was incidentally given under this section to solidification of ingots and to recrystallisation. The third sub-section was devoted to light metals and their alloys, special reference being made in this connection to the mechanism of age-hardening and the study of single crystals.

In the fourth sub-section attention was given to the general subjects of workability and wear, referring especially to machinability on the one hand and to wear tests and their relation to service life on the other.

In the third group, dealing with light metals, some reference was made to cast aluminium alloys, whilst in considering the question of wear some two or three Papers made reference to cast iron. On the whole, however, among the 64 Papers presented in the metals section, the majority dealt generally with the fundamentals of testing as applied to metallurgical products, and there was not a great deal of direct concern to foundrymen.

In the group dealing with subjects of general importance, the relation between the results of laboratory tests and behaviour in service was considered. In this section, as in the main metals group, the general conclusion would appear to be that whilst testing methods are being increasingly perfected, and whilst more refined methods of investigation are throwing a new light on the fundamental properties of materials, there is still a very wide gap between results of laboratory investigations and the life obtained in service.

Awards

The RETIRING PRESIDENT announced that the following Awards had been made for the year 1936-37:—

The Oliver Stubbs Medal to Mr. P. A. Russell for his very important work on behalf of the Institute.

The E. J. Fox Medal to Emeritus Prof. Thomas Turner, M.Sc.

Diplomas had been awarded to the following:—Mr. H. H. Shepperd for a Paper on "The Application of Science to the Control of Foundry Sands," read before the Birmingham Branch. Mr. S. A. Horton for a Paper on "Patterns and their Relation to Moulding Problems," read before the East Midlands Branch. Mr. R. Ballantine for a Paper on "Developments in the Production of Ingot Mould Castings," read before the Lancashire Branch and the Falkirk Section. Mr. E. W. Wynn for a Paper on "A Small Oil-Fired Rotary Furnace and its Products," read before the Lancashire Branch. Dr. C. J. Dadswell, Mr. T. R. Walker and Mr. F. Whitehouse, joint authors of a Paper on "The Manufacture of Iron and Steel Castings in Green Sand."

Honorary Member

The RETIRING PRESIDENT proposed that Lord Austin, K.B.E., of Longbridge, be elected an Honorary Member. He added that Lord Austin had been approached upon the matter and had said he was fully conscious of the honour, and the Institute felt that it was honouring itself by electing Lord Austin.

MR. J. E. HURST, seconding, said that Lord Austin, by reason of his many activities and the fact that he controlled very large foundries, would be a very worthy Honorary Member of the Institute. The proposition was unanimously adopted amid prolonged applause.

Election of President

The RETIRING PRESIDENT said that his own very natural reluctance to relinquish office as President after so pleasurable a year was lightened by the fact that he would be followed by so worthy a successor as Mr. C. W. Bigg, whose work for the Institute had been continuous ever since he had joined. He was one of those men who was always alongside his fellows and was unanimously declared to be one of the right sort. He was second in command of one of the largest foundries in Derby, and it was a great pleasure to propose his election as President for the ensuing year.

MR. V. JOBSON (chairman of Qualcast, Limited), as a colleague and friend of Mr. Bigg for more than thirty years, seconded the proposal. Mr. Bigg's associates in the company, he said, were very proud indeed that he had been selected for the honour, and they would do all they could during the year to ensure that he would be able to give to the Institute the time which his office demanded. There could be no better man for the office, for not only had he remarkable ability, but he had humanity and commanded the affection of his associates.

MR. E. J. FOX
(Donor of the E. J. Fox Medal).

MR. H. BUNTING (retiring President of the East Midlands Branch) supported the proposal. The Branch, he said, had a good deal of pride in the fact that it had trained Mr. Bigg, and they knew that he would rise to any call that might be made upon it. He would follow worthily other members of the Branch who had served as Presidents of the Institute—Mr. S. A. Gimson and Mr. S. H. Russell.

MR. C. W. BIGG was unanimously elected, and he expressed his great appreciation of the honour which the members had conferred upon himself personally and the Branch. He assured the members that any small talents or virtues that he might possess would be placed unreservedly at the service of the Institute.

Vote of Thanks to Retiring President

MR. C. W. BIGG proposed a hearty vote of thanks to Mr. H. Winterton for his great services to the Institute, and congratulated him upon a very successful year of office as President. No man, he said, could have thrown himself more whole-heartedly into the job; every little bit of Mr. Winterton had gone to make a job of his presidential office, and he had succeeded. He could look back to a year of record membership; to the formation of the East Anglian and the Bristol Sections; to the formation of the South African Branch; to the conjoint meeting held with the Iron and Steel Institute in the autumn of 1936, and to the general expansion of the activities of the Institute. The feelings between the President and the Senior Vice-President during the past year could not possibly have been better than in fact they were, and Mr. Bigg acknowledged that he had been able to form a personal friendship with Mr. Winterton which he valued very highly.

MR. F. J. COOK (Past-President), seconding, said Mr. Winterton had done much to bring the Institute to its present position, and his year of office had been very pleasurable and profitable to the Institute. The vote of thanks was carried with acclamation.

MR. WINTERTON, responding, assured the members that his work during his year of office had been a labour of love, and he was indeed proud to have been able to help the Institute along. It had entailed a great deal of travelling, but he had done his best to visit every Branch and Section during the year; it was rather unfortunate that the South African Branch was not actually formed until rather late in his year of office, and he could find no reasonable excuse to pay a visit there! He took the opportunity to express his great appreciation of the support afforded him by the Vice-Presidents, hon. treasurer, the general secretary and all the members of the Council.

Election of Vice-Presidents

MR. BIGG, proposing the election of Mr. J. Hepworth, J.P., M.P., as Senior Vice-President, paid a tribute to him in respect of his work for the West Riding Branch of the Institute, his very live interest as a specialist in the industry, and his wider experience as a national legislator, which should enable him to fill the post as Senior Vice-President with credit to himself and with benefit to the Institute. The resolution was seconded by MR. S. W. WISE, the honorary secretary of the West Riding Branch, and was carried unanimously.

MR. HEPWORTH, expressing his appreciation of the honour conferred upon him and upon the West Riding Branch, assured the members that he would give willingly as much of his time as he could possibly give to the Institute's work.

MR. V. C. FAULKNER, F.R.S.A. (Past-President), proposed that Mr. W. B. Lake, J.P., be appointed Junior Vice-President, and said that the reason why the Council had chosen this particular time to recommend Mr. Lake's election as Junior Vice-President was that in the ordinary course of events he would preside, as President of the Institute, over the International Foundry Congress, to be held in England two years hence. Mr. Lake, who was an important foundry owner, was the first man to make a steel casting with the aid of electricity in England, and the first to make a steel casting with the aid of the Sandslinger. He was also a very good employer, for he gave members of his staff every facility to participate in the activities of the Institute. In 1928 he had presided with great distinction over the London Branch, and subsequently had been a very strong supporter of the new East Anglian Section, which had been launched successfully. For the last seven years he had been hon. treasurer of the Institute, and it was hoped that in future he would play an even greater part in its development. Mr. Faulkner coupled with the proposal a hearty vote of thanks to Mr. Lake for his wonderful work in the past.

MR. D. H. WOOD, seconding, referred to the able manner in which Mr. Lake had piloted through the Finance Committee and the General Council a proposal that all the funds in the

Branches should be handed over to the General Council. The resolution was carried unanimously, and MR. LAKE briefly responded.

Election of Auditors

J. & A. W. Sully & Company, chartered accountants, were unanimously re-elected auditors for the ensuing year.

Election of Members of Council

The result of the ballot for the election of members to fill the five vacancies on the Council was as follows:—Prof. J. H. Andrew, Mr. V. Delport, Mr. E. Longden, Mr. P. A. Russell, Mr. D. H. Wood.

Civic Reception

In the evening the members and ladies attended a reception at Bemrose School, Uttoxeter Road, Derby, by kind invitation of the Worshipful the Mayor (Councillor Mrs. Petty, J.P.) and the Corporation of Derby.

OPENING OF CONFERENCE

On Wednesday morning, June 9, the members and their ladies assembled in the Guild Hall, Market Place, Derby, where they were officially welcomed by The Worshipful the Mayor of Derby (Councillor Mrs. Petty, J.P.), the President of Derby Chamber of Commerce (Mr. Cecil Murray, M.I.Mech.E), and the Principal of Derby Technical College (Dr. W. A. Richardson, O.B.E., B.A., D.Sc., B.Sc.(Eng.), F.G.S.), who were introduced to the meeting by Mr. H. Winterton (Retiring President).

THE WORSHIPFUL THE MAYOR OF DERBY assured the members and visitors that it was a privilege, in her capacity as the chief citizen of Derby, to extend to them a hearty official welcome. The fact that the members of the Institute were concerned with the casting of metals was a reminder that Tubal Cain was known as the first artificer of metals. Those who were old-fashioned enough and wise enough to read seriously the Old Testament—one could take it for granted that they all read the New Testament—would remember that the Philistines conquered the Children of Israel because the latter did not understand the casting of metals—for that was practically what it meant. Thus in the olden days a small nation, with great and wonderful ideals, was beaten back because the people could not use their hands in a certain direction and could not create the weapons of defence which they needed if they were to apply the ideals which their teachers and their prophets had expounded to them. In that there was a moral to take to heart and to ponder upon.

Although, continued the Mayor, Derby did not claim to be the oldest Borough in England, it was proud of the fact that it was considered a Borough even 1,000 years ago. Industrial people who had lived there had been pioneers in many ways. The first factory in England was built near the Derwent, where the electricity works now stand. Derby had played an important part in the development of silk weaving. That process had been a secret which Italy had very wisely secured from China and had carefully retained for many years; but John Loan, of Derby, had successfully entered into competition in the weaving of silk. There were some most wonderful examples of wrought ironwork in Derby, particularly in the Cathedral, of which the City was justly proud; it was hoped that many of the wonderful pieces of ironwork in various public places in Derby would eventually find their way into the safe care of the municipal authorities.

Commenting upon the fact that representatives of many countries were attending the Institute's conference, the Mayor emphasised that the more the representatives of the different countries met together in friendly conference and discussed their domestic and international troubles, the easier was the way towards that peace without which the world could never prosper. Difficulties must be discussed as brothers and sisters in one huge community—for that was what the world was coming to—and probably it lay with the present generation to make the choice as to whether the world was to go forward into an era of prosperity, happiness and peace, realising the spiritual values which made life so grand, or whether it would take the other line which led to destruction, misery and probably the end of Western civilisation. May the Derby convention of the Institute be interesting and encouraging, and contribute to the creation of the era of peace for which we all longed!

MR. CECIL MURRAY, M.I.Mech.E. (President, Derby Chamber of Commerce), offering a welcome to the Institute, said he was not sure that he had the authority to speak officially on behalf of the Chamber of Commerce; but, knowing something of the business men of Derby and of the Institute of British Foundrymen, he had no hesitation whatever in offering the Institute a hearty welcome on behalf of the Chamber of Commerce Several members of the Institute were members of the Chamber of Commerce. In choosing to hold its conference in Derby, the Institute paid a compliment to Derby foundrymen, not merely by reason of the success of their particular undertakings, but perhaps also as a special tribute to the part they were playing and the interest they were taking in the general development and the welfare of the foundry industry. There was a close contact between the Institute and Derby. If the Institute's motto, "Science hand-in-hand with labour," were treated as a cross-word puzzle, one came down to the word "craftsmanship," which was very important to Derby, which had a great variety of industries. Perhaps of greater importance, in most of those industries the Derby firms were right at the top of the tree, their products bearing a world-wide reputation for general excellence. That reputation had been built up over a period of many years, and was due in no small measure to the craftsmanship of the Derby workmen. Derby was doing its best to maintain that high standard of craftsmanship, and was taking as great an interest in technical education as was the Institute; so that there was a very close bond between the industrialists of Derby and the Institute. The engineering industry knew the tremendous amount of work which the Institute was doing in the way of research, and the Derby foundries were taking a great part in that work. There was very little that was handled to-day to which the skill of the foundryman had not contributed—either in its manufacture or in the machinery used for its manufacture.

THE MAYOR OF DERBY (COUNCILLOR MRS. PETTY).

Mr. Murray added that Derby was delighted that the Institute had paid to the Derby foundrymen the compliment of holding its convention in the city; and in offering the members and visitors a hearty welcome, he expressed the hope that their conference would be very happy and successful.

DR. W. A. RICHARDSON, O.B.E., B.A., D.Sc., B.Sc.(Eng.), F.G.S. (Principal of Derby Technical College), expressed his appreciation of the fact that he had been asked, as a representative of technical education in Derby, to join in welcoming the Institute. The foundry industry, he said, was a scientific industry; there were more applications of common science and uncommon science in the foundry than in any other section of an engineering works. It was amazing to a man such as himself, having some little scientific knowledge, to find how many real problems there were in the foundry, and how very interesting they were, despite the fact that the foundry itself was not, as a rule, a very attractive place. He congratulated the Institute on the very prominent part it was playing in the education of the young people in the industry. It seemed a tragedy that loam moulding, which was one of the arts of the world, to say nothing of the science, seemed gradually to be going out of practice; he knew of nothing more interesting or beautiful than a really good loam mould, and regretted that in a good many of our foundries only the older men were doing that work, there being no youngsters coming on in that direction.

The Institute had recognised that the young people needed education, and had taken great steps nationally and locally to establish technical educational facilities for them. The local Branch of the Institute in Derby had been very energetic and progressive, and Derby was one of the few areas in which the employers were giving their young workers the privilege of taking time off for the purpose of attending classes during the day. The Committee of the Branch had introduced that policy at the time when Mr. Bigg, the Institute's President-Elect—a gentleman for whom the whole town had a very great regard—was Branch-President. Mr. Bigg, and his predecessors in the office of Branch-President, had rendered great help to the Technical College, and he hoped they had seen no reason to regret having advised the foundry employers to allow the young people time off in order to attend classes at the College. As the result of that, the College staff were able to do their job better, and he hoped the industry was receiving something in return.

Dr. Richardson also said a word or two in praise of Mr. H. Bunting (retiring President of the East Midlands Branch), who not only could teach at the Technical College, but could also entertain the members of the Institute whenever they met! To the Technical College he had rendered very great assistance.

Appreciating how much the Institute and the local Branch had done for education, Dr. Richardson assured the members that he would be glad to do anything he could to assist.

Presentation of the Oliver Stubbs Medal

The Oliver Stubbs Gold Medal was presented by the Mayor of Derby to Mr. P. A. Russell, of Leicester, for his outstanding services to the Institute.

In acknowledging the award, MR. RUSSELL said he was greatly flattered to receive the medal, which was held in great esteem by all members of the Institute. The award would be an encouragement to proceed with such work as he had been able to do, particularly in connection with the work of the Technical Committee;

that work was very largely co-operative, and he accepted the medal partly on behalf of his colleagues on the Cast Iron Sub-Committee.

The E. J. Fox Medal

MR. H. WINTERTON, inviting Mr. E. J. Fox to present the Gold Medal established as the result of Mr. Fox's generous gift of £500, to encourage work in connection with the foundry and particularly with regard to metallurgical research, said that the recommendation of the assessors, Sir William J. Larke and Sir Harold Carpenter, that the first award of the medal be made to Emeritus Professor Thomas Turner, M.Sc., would be particularly popular, for the value of Prof. Turner's services to the industry was untold.

MR. E. J. FOX, before formally presenting the medal, read the following extract from the assessor's report, dated March 24, 1937:—

> "We desire to recommend that the E. J. Fox Medal for the current year be awarded to Prof. Emeritus Thomas Turner, M.Sc., as a recognition of his work on the effects of silicon on cast iron and his other contributions to the metallurgy of cast iron which may be said to have formed the foundation of modern foundry practice. We feel that in thus honouring Prof. Turner the Institute will be honouring itself and placing the award of the E. J. Fox Medal in a category which will confer distinction on any future recipient."

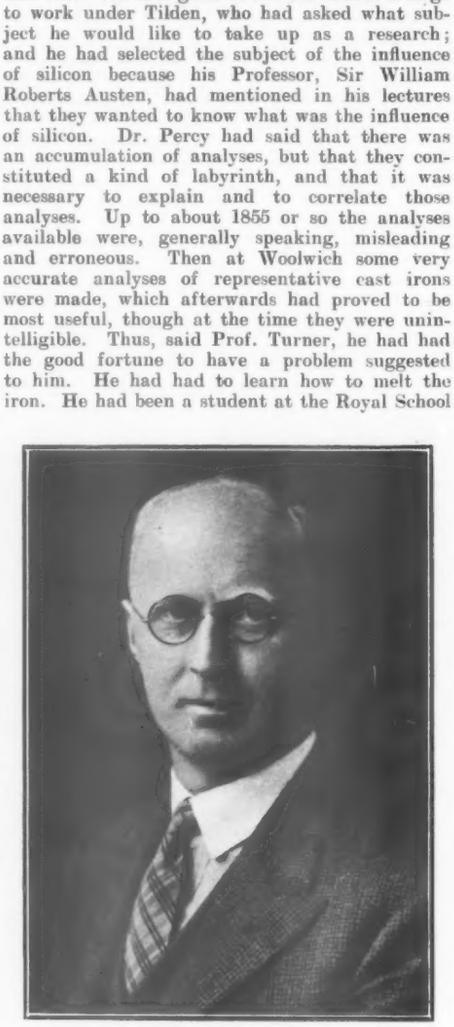
Until a few years ago, said Mr. Fox, Prof. Turner was Professor of Metallurgy at Birmingham University, where he had established one of the best-equipped metallurgical departments in the country. His outstanding work was his research on the influence of silicon on cast iron, carried out as early as 1885, a classic work which had laid the foundation of scientific iron founding. His life-work had been the furtherance of metallurgical knowledge, both by personal investigation and by the guidance of students and other workers into useful fields of research, with special reference to industry.

It was not out of place to recall that two Prime Ministers of this country had been students of Prof. Turner; they were Earl Baldwin and the Rt. Hon. Neville Chamberlain. Sir Henry Fowler, whose name was known throughout the world and who was particularly respected in Derby, was another student of Prof. Turner. The researches of Prof. Turner covered all metallurgical fields, both ferrous and non-ferrous, and his vast contributions to our knowledge of the constitution of alloys, the shrinkage and expansion of metals, the corrosion of alloys, etc., indicated the full life he had devoted to the cause of science. His fame as a metallurgist had carried to all parts of the world, and his opinion was sought and respected in all branches of industry and education. Mr. Fox derived great pleasure from the fact that the first award of the Medal was made to Prof. Turner, first because it was a compliment to the name of Fox and his effort to provide some incentive and to encourage further research by the younger generation, and secondly, because the Medal started upon its career with the hall mark given to it by its recipient, which would result in making it a prize much coveted in the years to come, so that it would really encourage further research which would redound to the advantage of all founders of iron, who had almost a conceited belief in the merits of their metal and were daily working to secure improved results.

Mr. Fox formally presented the Medal to Prof. Turner, together with the certificate which accompanied it.

PROF. T. TURNER, responding, confessed that he found it difficult to find appropriate words with which to express his gratitude. Although, he said, reference had been made to his deeds, Mr. Fox had kindly refrained from mentioning his misdeeds.

It was 52 years since he had read his Paper on the influence of silicon on the properties of cast iron. He had gone to the old Mason College to work under Tilden, who had asked what subject he would like to take up as a research; and he had selected the subject of the influence of silicon because his Professor, Sir William Roberts Austen, had mentioned in his lectures that they wanted to know what was the influence of silicon. Dr. Percy had said that there was an accumulation of analyses, but that they constituted a kind of labyrinth, and that it was necessary to explain and to correlate those analyses. Up to about 1855 or so the analyses available were, generally speaking, misleading and erroneous. Then at Woolwich some very accurate analyses of representative cast irons were made, which afterwards had proved to be most useful, though at the time they were unintelligible. Thus, said Prof. Turner, he had had the good fortune to have a problem suggested to him. He had had to learn how to melt the iron. He had been a student at the Royal School



P. A. RUSSELL
(Oliver Stubbs Medallist).

of Mines, but no iron founding was done there, and he had had to learn how to make his own moulds. A young man attached to a local foundry had assisted him. The first mould they had made was not dressed sufficiently and was a little dry, so that the metal ran out from the side and left a mark on the nice red tiled floor of the laboratory, which mark he believed was still visible. The next mould made was too wet and too solid, and he believed the metal in that case had made a mark on the ceiling! After that he had thought that he knew enough about the moulding to make his own moulds, and he had proceeded successfully. He had had to do the melting, the moulding and the analyses afterwards. Nowadays, of course, research was much more complex and there was a great deal of team work, but in the early days there were many simple problems which could be attacked by one man, and he did not think that the young researchers of to-day could derive quite the pleasure that older researchers did when they had found their experimental results gave smooth curves, that they could say definitely what the results were and that they had done the work themselves.

However, knowing the influence of silicon and having a large number of analyses available, it had become quite easy to experiment with irons which had the right amount of silicon but varying amounts of phosphorus, the right amount of silicon but varying amounts of manganese and the right amount of silicon but varying amounts of sulphur. So that within a short time he was able to say broadly what was the influence of each of the elements. He had never received any monetary recognition for that work and had had to meet some of the cost of it out of his stipend, which was £100 a year. The work had, however, given him great pleasure; it had helped him later in various ways and it had brought him many friends; perhaps the latter was the greatest reward that one could have for such work. It was not often that a man lived to see the work that he did more than 50 years ago being still appreciated by and of use to other people, nor did it fall to the lot of many to retain for so many years friendships such as those existing between himself and the foundrymen.

Finally, Professor Turner said that his family —Mrs. Turner and their son, Mr. T. H. Turner, who were present at the meeting—very much appreciated the honour the Institute had done him.

Vote of Thanks

MR. H. WINTERTON proposed a hearty vote of thanks to the Worshipful Mayor of Derby and to Mr. Murray and Dr. Richardson for the welcome they had extended to the members of the Institute.

The vote of thanks was seconded by MR. BIGG, who acknowledged that he had a distinctly personal sense of obligation for all that had been done to contribute to the success of the Conference by the authorities at Derby. Those sentiments, he said, were shared by every member of the Institute. The vote of thanks was accorded with enthusiasm and the Mayor briefly responded and withdrew from the Conference.

Induction of New President

MR. WINTERTON, inviting his successor formally to take office, expressed his personal appreciation of the support he had received during the past twelve months from officers and members of the Institute as well as from his colleagues in William Cumming & Company, Limited, who had had more work to do by reason of the fact that their Chairman had been away from the works many times. He formally invested Mr. Bigg with the Presidential Chain of Office, and wished him a very happy year.

MR. BIGG, who was received with applause, formally occupied the Chair and said that he hoped to demonstrate during the next twelve months how very much he appreciated the honour.

Gift from Qualcast, Limited

MR. BIGG announced with pleasure that his co-directors of Qualcast, Limited, wished to mark the occasion of his accession to the Presidential Chair of the Institute in a tangible manner and had offered the Institute the sum of £500 to form the nucleus of an endowment fund to be used to promote the work of the technical and educational Committees. The fund would be administered by trustees, and he invited the meeting to indicate acceptance of the gift, which would be subject to confirmation by the General Council in due course.

MR. S. H. RUSSELL (Past-President), proposing that the meeting should indicate its acceptance of the gift and its gratitude to the directors of Qualcast, Limited, said that some of them felt a little overwhelmed by the very substantial amount of the gift. He had not the slightest hesitation in saying that subsequently it would be accepted by the General Council with very grateful appreciation, and that it would be administered with care. The aim was to use the money as the nucleus of a larger fund, which it was hoped would grow until the interest it earned would be sufficient to foster the different enterprises undertaken in connection with the work of the two Committees. It was the dearest

wish of Mr. Bigg that in time the Institute should be in a position to finance work of urgency and importance, provided always that that work did not cut across the work of any other body.

MR. J. W. GARDOM (Convener of the Institute's Technical Committee) seconded. The first thought of a hard-working metallurgist, he said, when so munificent a sum was offered was "Let us take it and do something with it," and all who were concerned with the progress of the Institute's work were indeed grateful to the donors. It seemed, he added, that the President had been aptly named (Charles Bigg) for "Charles" was the name of one of our most lovable monarchs, and the President was "Bigg" in heart and in thought. All must feel the seriousness of the matter and the necessity for ensuring that the money was spent wisely. It was a big sum but it might very easily be thrown away unless the greatest care was exercised. The problem of appointing trustees was a matter to be considered very thoroughly from among the men who had real business in them quite apart from their scientific attainments. His knowledge of the work of the Technical Committee provided sufficient proof that there were ample opportunities for spending money wisely and well. It must be borne in mind that the use of the results of the research work that was done must be considered very carefully. Academic research scholars, with whom he had had some connection, would be among the first to admit that their good work was sometimes ruined, or at any rate it was not used properly in industry. The Institute's Technical Committee was composed of men who could understand thoroughly the value of anything that was put forward by an academic scholar, and could show the value of such work to the foundry industry. By so doing they would overcome some of the troubles which foundrymen experienced to-day. The resolution was carried with acclamation.

MR. V. JOBSON (Chairman, Qualcast, Limited), who was invited to respond, said that his colleagues and himself had felt that a fund ought to be established if possible, and their idea was to use the £500 as a nucleus; he hoped others would build up the fund and that much useful work would be done through its agency. He personally appreciated very much the assistance he had received at all times from technical people.

Presentation of Badges

A Past-President's badge was formally presented to Mr. H. Winterton; the Medallion worn by the President's wife was presented to Mrs. Bigg, and the Vice-Presidents' Medallions were presented to Mr. Hepworth and Mr. Lake.

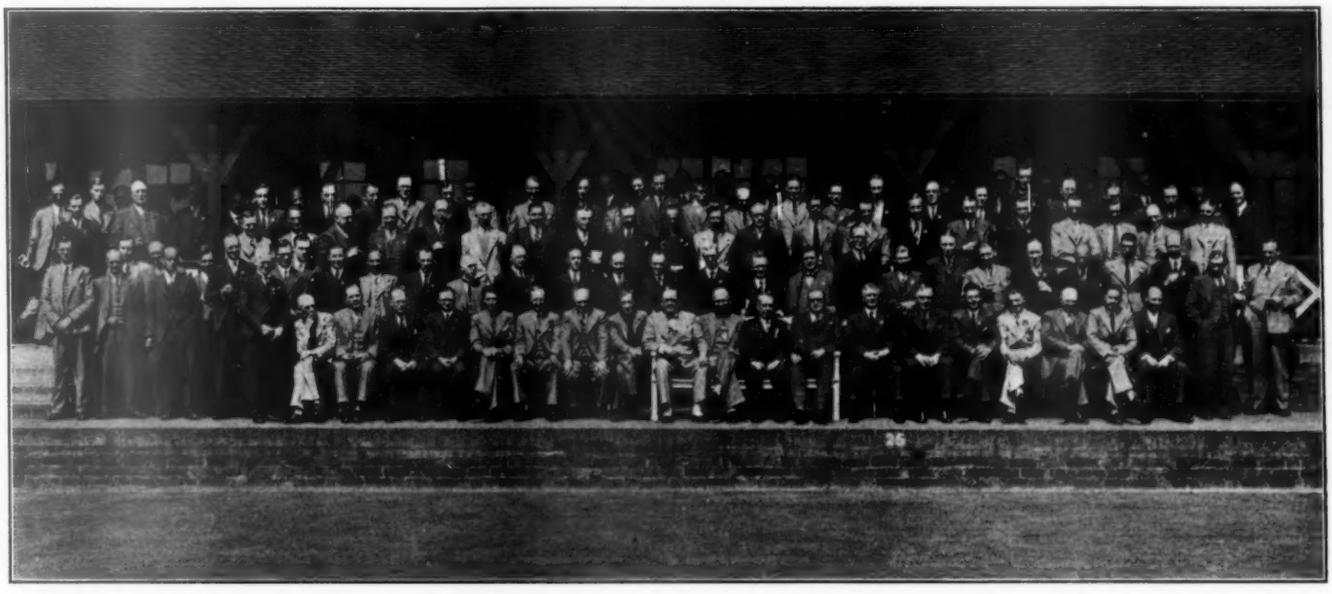
Honorary Treasurership

It was announced that MR. S. H. RUSSELL (Past-President) had been elected hon. treasurer to the Institute in succession to Mr. Lake.

Visitors from Overseas

A hearty welcome was extended to the many members and visitors from overseas who were attending the Conference. They included Mr. O. W. Ellis (Director of Metallurgical Research, Ontario Research Foundation, Toronto, Canada); Mr. Spring, Mr. Thomas, Mr. Galbraith, Mr. C. R. Day and Major Briggs from Australia; Mr. Drakenburg from Sweden; Dr. Röhrig (Germany); Mr. and Mrs. Bean (Persia); Mr. and Mrs. McNab (Singapore); Mr. Paul Fassotte (Brussels) and Mr. W. A. Giesler (Germany).

Mr. Bigg then delivered his Presidential



MEMBERS OF THE INSTITUTE OF BRITISH FOUNDRYMEN PHOTOGRAPHED WITH THEIR HOSTS AFTER LUNCHEON AT THE STANTON IRONWORKS COMPANY, LIMITED.

PRESIDENTIAL ADDRESS

Mr. Winterton and Gentlemen:—

Does our industry from the community in general, receive tangible recognition?—recognition commensurate with its contributions to, and importance in, the general scheme of things. Or, to put it very crudely indeed, for what the foundryman does, what does the foundryman get? I am not going to develop this theme simply on the lines of an application for an increase in salaries or profits. I am going to attempt to indicate the bearing this question has on certain of our problems.

One of the most urgent problems with which we are concerned is the recruitment of personnel, and by personnel I mean not only the heads of departments, but the whole body of recruits for the different sections of the whole of our industry, which must contain the material from which the heads of departments are made. Unless we get the right type of recruits, we can never expect to have men directing our industry who will keep it in a position worthy of its importance.

I do not suggest that we should legislate on the basis that every lad coming into our industry is going to be worthy of a managerial position. We want the type of youth which is likely to contain among its ranks a good proportion who can be developed into controlling and directing executives. If that is achieved, we can rest assured that among the large remainder there will be a healthy supply of good craftsmen and technicians. What do we require in our foundrymen, and what are our chances of getting such men? Our industry's need is for men with practical experience, which practical experience has been informed, strengthened and enlarged by a sound technical training.

Internal Training Essential

Through my membership of the Institute, I have been brought into fairly close contact with our activities in connection with the different educational bodies with which we co-operate in efforts towards increasing the knowledge of the foundryman. I am full of enthusiasm for what is already being done, and for still further developments in these several directions, but no matter what facilities are placed at the disposal of our young men by these very excellent arrangements, it does not relieve the industry of one little bit of its own great responsibility in this matter. I want to emphasise that the real training for our industry must be in and by the industry itself. We shall never be able to get ready-made foundrymen from any outside source. We have got to make them.

In spite of the fact that the responsibility of thought and of judgment is tending to pass from the operator to the administrator, I can imagine no industry where the human factor will prove so permanently and largely a necessity as in the foundry. No matter to what degree we may develop our different forms of specialisation, organisation and mechanisation, unless these are scientifically based on craft experience they will fail.

I am of the opinion that in the higher executive, directing and controlling a concern, there must be a good leavening of practical knowledge, sufficient to prevent the directional control from soaring too far up into the clouds of impracticability. Far too seldom does the practical foundryman achieve or even aspire to a place in the direction of things, and because of this, it must of necessity follow that consideration of the foundry's needs and problems is usually belated and scanty.

It is our responsibility as an Institute to aim at producing for and in our industry men who combine technical and practical knowledge of a sufficiently high quality to ensure for them the leading places in our industry, and secure for the industry itself a leading place in the larger industrial world.

Lack of Technical Co-operation

I am not digressing if I take this opportunity of referring to the difficulties which are sometimes encountered when the technical and the practical men meet. You will not accuse me of exaggeration when I say that the practical lions and the technical lambs of our industry, and also of our Institute, too often refuse to lie down together.

Why is it? First of all, there is so often very little understanding one of the other. From the man working on the floor, with all the varying complexes which only working on a foundry floor can give, we have his very human, but quite unjustified, resentment of receiving instructions or even assistance from a colleague who he considers has never soiled his hands or taken off his sanguinary coat, and who, because of these deficiencies in his training, simply cannot be aware of the thousand and one problems a poor moulder has to face, and on the other side, there is sometimes an attitude indicating that the man on the floor is of no account, and can be treated simply as a hewer of sand and a thrower of water.

What are we going to do about this? I do not wish to be considered harsh in my judgment, but there are times when I hold the opinion that where we are concerned with the processes of thought, and the habits engendered by a lifetime's experience, to effect a change is tremendously difficult, and in some cases almost impossible, but we can and must so legislate that in the foundryman of the future these two vital factors are welded as closely as possible into one. I need not emphasise the achievements of the non-technical foundryman. The world is full of tributes to his amazing practical and artistic skill, and he can claim that until fairly recently he got along with little or no technical assistance, because it was not at his disposal.

Better Type of Recruits Needed

Our Institute exists mainly for the provision of this technical knowledge and assistance, and depends for its continued success on a supply of men who can appreciate the benefits to be derived from its membership. The examination of our requirements results in the opinion that for the proper functioning of our industry we need combined practical and technical intelligence of a very high degree.

An association of technically and commercially uninformed artisans, no matter what their individual skill, cannot keep our industry or our Institute in the front rank.

Now I arrive at the question: Is our industry in any of its branches attracting to its ranks in any numbers the type of man indicated as necessary? One's own experience, the opinions generally expressed when foundrymen foregather, our trade journals, are all eloquent of the fact that we are not. THE FOUNDRY TRADE JOURNAL when dealing with this matter a few months ago, said "It has been a commonplace for years that the quality of the youths entering founding is lower than that of those entering the engineering trades for such occupations as fitting, turning, and so on. Fathers who are moulders are less willing than they were that their sons should follow in their trade, and consequently the calibre of entrant is bound to diminish."

Why is it so? What governs a young man in his choice of a career? His own inclinations, desires and reasoning, coupled with the advice of his elders, to all of whom the main question is "What does the career under consideration promise in working conditions and material prospects?" Some of you may be of the opinion that we as an Insitute are not concerned with the material prospects side of the problem. Can we as an Institute consider our industry's development in research, organisation or personnel—and you must agree that we are vitally concerned with these three aspects—without being forced to give consideration to, and to form some opinion on, the material prospects phase of the situation? In any case, in developing my arguments this morning, I am unable to escape it.

Modern Youth

Modern youth is criticised as has been the youth of all time, but we have to remember that the modern youth is more critical than his predecessors. The ambitious, well-intentioned youngster does exist even to-day, and we want him in our industry. What do we offer to such a youth in search of a career in whatever section of our industry his particular conditions and training fit him for? Are we able to say that the conditions and rewards of our industry, apart from isolated examples, are such as to be attractive to intelligent and aspiring young men? Can we expect the type of youth who is going to develop into this man of dual and complete attainments, to whom we have referred, to be attracted to any but the most exceptional foundries? It is not easy for him to find a much more congenial calling, and if a lad is willing to brave the conditions he will find in so many foundries, are the usual material prospects such as to offer some compensation for the unsatisfactory conditions which exist?

The knowledge and skill required in a foundry are certainly not less, and are most probably more, than those required in much more remunerative and less unpleasantly arduous occupations.

General Improvement Essential

Lord Austin, at our Birmingham Branch dinner, said that he had never been able to understand why the foundry had always been the "Cinderella." Can we expect ambitious young men to be attracted to an industry which carries such a label? There is plenty of evidence that this is one of our industry's main problems and we as an Institute have to face it. If this reasoning be correct, then we must aim at less arduous toil in more attractive surroundings by improving the construction and lay-outs of our foundry buildings and by the introduction at a much accentuated rate over the present one of methods and plant for elimination of the heavier tasks attached to the production of castings, and as an industry we must be prepared to negotiate on competitive monetary terms for men capable of filling responsible posts. I submit that this difficulty with regard to personnel has to be considered on a very much wider basis than just a shortage of recruits. I contend that it is largely a reflection of the general conditions of our industry, and that a satisfactory supply of recruits can only be expected as a parallel of a decided improvement in those general conditions.

Lord Austin is a very able man, a man so able and successful as to render his opinions worthy of serious consideration, and for him to refer to the foundry as the "Cinderella" is another reminder of our lowly status in the industrial world. To many of us, this represents another very real problem, and I would like to devote a few moments to its consideration.

Assessing the Blame

Let me quote further from Lord Austin's speech at Birmingham. After referring to the foundry as the "Cinderella," he continued by saying, "The foundry still lags behind other departments. I do not think it is the fault of the foundryman, but the fault of the financier and the engineer, who have not appreciated as they should have done the big things there are to be gained in a well-organised, well-equipped and well-run foundry."

I am going to ask, "Does the foundryman himself appreciate what is to be gained by a well-organised, well-equipped and well-run foundry?" I do not blame the financier and the engineer. I would like to convince you that the responsibility is ours. Is it not true that our industry for longer than any other, relied almost solely on what I have called "the individual skill of technically and commercially uninformed artisans," and that even to-day a large section of the industry has changed but little in this respect? This being so, what chance have we of getting our deserts from the technical and commercial giants with whom we have to battle? We cannot expect the financier or the engineer, of their own volition, to show us the consideration we think we deserve. We have to save ourselves or we are lost. One's impression of the situation is very largely this: Here are we, claiming to be the basis of all engineering industry, continually bemoaning the fact that we are the "Cinderella," that we are called upon to make castings of improbable design at impossible prices, that neither the designer nor the buyer gives any consideration to the foundry, that the foundry from both the designer and the buyer has to take what it can and not what it ought to get. Is not this very largely a confession of failure on our part?

Designers' Difficulties

Let us deal first of all with our complaint about that much-maligned individual, the designer, who, many of us think, is too often prone to ignore what to us are fundamentals. The designer does generally realise to the best of his ability that the efficiency of the ultimate product demands that the design of the casting shall be dictated, not only by the requirements of the engineer, but by expert knowledge of the materials and processes used in the production of castings. Foundrymen are continually claiming that this expert knowledge is not evident in much of the work of the designer. If such be the case, then it means that sufficient knowledge of this type does not exist among the designing fraternity. Is not the responsibility for this also largely our own? The knowledge of our industry must come from our industry. Have the conditions in our industry been such as to produce sufficient men with this expert knowledge, and the ability to interpret that knowledge in the form of design or to the draughtsman so as to influence general casting design along the right lines? Am I not correct in stating that so far the users and designers of castings have not had a tremendous amount of help and instruction from the foundry industry itself? We must not console ourselves with the statement that they will not let us help them. We have somehow got to convince them that we can do so. They have not, and they will not, look to the ordinary non-technical foundryman for this assistance. If we provide the right sort of help in this connection, the engineer and the designer will be glad to avail themselves of it.

Ambassadorial Requirements

We are all agreed upon the desirability of improving the status of our industry and our Institute. This means that we are claiming recognition and consideration from our industrial contemporaries, but we shall not convince the engineer, the designer, or the financier from, or in, the sand heap. We must have men in our industry with the ability to present our case in the drawing offices, the laboratories, and the board rooms of the industries for which we cater.

I suggest to you that the problems of foundry personnel and foundry status are closely connected. Improve the one, and you will improve the other, but we shall not attract to our industry the type of man we require, nor shall we improve the general status of the industry, unless and until we improve the general conditions of the industry, and by general conditions, I mean everything that goes to make up the life of a foundryman. It was in this connection that I asked the question, "For what

the foundryman does, what does the foundryman get?"

I believe that we are unanimous in the opinion that the general conditions in our industry are not what they should be. How can they be improved? If we, as an industry, were "well organised, well equipped, and well run" we, should have good conditions, we should compete successfully for the best among the recruits to industry, we should command the consideration of the engineer, and the respect of the financier.

A Badly-Organised Industry

Does our industry in general consist of foundries that are well organised, well equipped, and well run? I am afraid the answer has to be in the negative. Let us consider for a few moments the question of organisation. A lecture on this subject is outside my present purpose, but I want to emphasise its importance as affecting the problems under consideration. I hold the opinion that in our industry as a whole, as well as in our individual foundries, organisation is not very strongly in evidence.

In referring to organisation as applied to the whole of an industry, many people at once think of a strong trade association for the maintenance of price levels. I am going to claim that the greatest protection for our or any industry is efficiency, and it is this rather than price maintenance which should be the object of trade associations. Efficiency in an industry is the only guarantee to the community of real service from that industry. We as an Institute have no desire or claim to study the question of profits, but we exist for the promotion of efficiency in the industry. Given all round efficiency, profits will not be problematical.

Increased Efficiency Essential

We are vitally concerned that our services to the community shall be of ever increasing value. This latter, to put it very simply, means that the purchasing power of the community in relation to our industry must be continually increasing, and for that to be achieved, we must produce better castings at relatively lower prices, and yet maintain a high and improving level of living for all employed. There is evidence in several highly-successful industries that this can be done by efficient methods, and our policy should be to convince industry that the Institute of British Foundrymen exists for the scientific advancement towards efficiency along the lines of education, research and development of every phase of foundry production.

What does organisation mean as applied to the individual foundry? The dictionary tells us that science is knowledge reduced to system. I would say that organisation means effort reduced to system. Its application ultimately means effort reduced *by* system.

The foundry industry generally is run on the lines of prodigality of effort, and surely, faced as we are by the probability of a serious shortage of personnel in all the branches of our industry, we should realise the value of any factor contributing to the conservation of effort.

The analytical mind should not be confined to the laboratory. There is a tremendous field in our foundries for analysis and the systematising of effort. Any effort which by proper organisation could be avoided is waste effort, and I would venture the opinion that waste effort costs our industry more than waste castings.

Organisation is more important than equipment. Much good equipment has been rendered unproductive and uneconomic by bad organisation, but good organisation will very quickly discover the necessity and the wherewithal for good equipment.

Organisation is the proper and most important exercise of the managerial function. I hesitate to mention the word "management" in close conjunction with the word "scientific," because together they have been much abused, but we should realise that all good management must be scientific, even if all scientific management is not good management.

Organised Management

Let us aim, then, at organised management. The functions of a manager are too often limited to the making of arbitrary decisions, and the maintenance of discipline, and often, through lack of organisation, we find these two factors keeping him in a perpetually harassed state, without anything material being achieved in the shape of investigation or development. By applying the analytical and dimensional faculties to the direction of the energy expended in our foundries, we shall be conducting research in an almost unexplored field.

Organised management will devise systems which weld the many separate units contributing to production into one harmonious whole. Systems which ensure that the knowledge, experience and effort which are expended on a job to-day are to-morrow, not hanging by the slender thread of human memory, or lost in the limbo of forgotten things, but have left behind them in some easily accessible form, records which will contribute materially to every future job. Working along these lines of record, analysis and comparison, our foundry managements will appreciate the value of good conditions and will achieve them. They will see the necessity for good equipment, and will acquire it, and by their knowledge of their own particular circumstances, they will be in a position to select the best type of equipment for their own particular job.

My remarks so far have been intended as a plea for developments in management and equipment as contributing to better conditions and prospects leading ultimately to improved personnel and status.

Our Institute striving towards progress by means of education, research and development, is becoming increasingly conscious of the importance of the economic factor, so conscious as now practically to be forced to take steps to increase its income in order to provide the wherewithal for the maintenance of its progress, and to my listeners no doubt this plea for better conditions terminates mainly in a question regarding the wherewithal. They are probably quite convinced that with good conditions and good equipment, everyone connected with the foundry would have a better time, but where are these things coming from? Many claim that for years it has been difficult to keep one's head above water, in spite of economies in regard to salaries and plant expenditure, and so with a scarcity of personnel because of the poor conditions and remunerations existing, and an inability of the capital involved to improve those conditions, because of the inadequate returns such capital is receiving, many foundrymen find themselves at a loss for a solution to these problems. Yet for the realisation of our ideals, a solution has to be found.

Interlocking Progress

Let me repeat that I am fully alive to the fact that as an Institute, we are not supposed to be concerned with the economics of the industry, and by some I may be thought to be treading on dangerous ground, but as an Institute, we are actuated by a desire that our industry should progress, because we can have no existence apart from the industry, and the vitality of the industry is largely the measure of our own. In dealing with these problems of personnel and status, I am, as you see, brought up against the question of general conditions, and in dealing with the latter, I find it impossible altogether to avoid contact with the economic factor.

Adequate General Remuneration

Lest any among you should fear that I am going to talk about profits, let me define the limits of my considerations in this way: We, as a craft and industry, were hard at work at the very foundations of civilisation, and we have, ever since, continued to make tremendous contributions to the well-being and progress of mankind, and as an important constituent of that larger organism, the community, we have a right to claim a return for our services such as will enable us to work under good conditions with such remuneration as those engaged in an important industry are worthy, with something left over for research and development. All these things should be accounted for in assessing the value of our products.

That explanation claims a return for our efforts which is at least equal to our expenditure, and whether we are under a capitalistic or communistic *régime*, such return in some form must be assured if those engaged in the industry are to maintain what is generally accepted as good conditions of work and living. So, leaving profits out of the picture entirely, we will only consider ensuring to our industry a return based upon the value of its products. The remuneration of our industry is the governing factor in its standard of working conditions and life for all engaged in it. Continuous development, with constant improvement in working conditions, is the only standard we can be asked to consider. There can be no such development or improvement unless the return for our products, at its minimum, is equal to the efficient cost of those products. Anything less is detrimental to the industry and those engaged in it, and is eventually detrimental to the community.

It may be comparatively easy to achieve such a minimum at a time when demand exceeds supply—it may even be possible to approach an unjustifiable maximum, which will later have to be paid for in reaction—but what we want is the knowledge which will enable us, in both good and bad times, to consider the question "What ought we to get?" as well as, or even preferably to, the question "What can we get?"

My argument is not for increased prices. I claim that a well-organised, well-equipped, well-run foundry industry will result ultimately in the lowering of the cost of its services to the community, but such an industry will also have the knowledge and power to take some part in the assessment of the value of its products.

Need for Proper Costing

Now comes the question, "Has the foundry industry in general the knowledge necessary to assess the value of its products?"

I do not hesitate to reply in the negative, and I am equally emphatic in stating that to this particular weakness in our industry's structure can be attributed many of the disabilities which we as foundrymen consider to be our portion. It is because of this that I hold the view that in bringing the subject of costing to the fore, our Institute is doing a very real and necessary service to the industry.

I believe that many foundrymen think that costing is a job solely for the accountant, and is something quite outside the scope of the industry itself. To them I would like to say that costing is as integral a part of our industry as is the laboratory, and there exists no more important adjunct to organised management than a good costing system. Its value as a dimensional factor in the works as distinct from the office cannot be exaggerated.

A costing system, to be efficient, must be so modelled as to embrace and cater for the special circumstances attached to each industry and department, and should be so simple as to be interpretable by the head of the department concerned. Such a system can only be achieved by the co-operation and understanding of the foundry executive with the cost accountant.

Costing is not an abstruse subject. Its main constituents should be logical reasoning and simple arithmetic, and I suggest that none of our deliberations at this conference will be of

more important interest than those which centre round the report of the Costing Sub-Committee. I am not going to give you a foretaste of the Sub-Committee's findings, but in connection with the points I have raised I am anxious to direct your attention to what I consider to be an indispensable factor in the building up and maintaining of efficiency and good conditions in our industry.

The thirty-four years during which our Institute has existed have witnessed a more than remarkable development on the technical side of our industry. We have extended the knowledge of our materials to almost indescribable limits. The quality and scope of our products is evinced in the demands made upon us. There is not a section of industry to which by our products we do not make considerable contributions. Yet in spite of all this, among the foundry's chief problems are its lack of recruits and its lowly status. In my remarks I have endeavoured to point to improved conditions resulting from a higher level of organised efficiency as a possible solution.

The past, present and potential demand for castings, combined with the mental and physical efforts necessary for their production, form the fundamental basis of our industry's importance. With us lies the responsibility that our general organisation and efficiency is such as to produce conditions attractive to the best brains available and to ensure that the status of the foundry is among the highest in industry.

A hearty vote of thanks was accorded the President, on the proposal of MR. H. WINTERTON, for having presented some of the problems of the foundry in a completely new light and in a very convincing manner.

The "Edward Williams" Lecture

DR. C. H. DESCH, D.Sc., Ph.D., F.R.S. (Superintendent, Metallurgical Department, National Physical Laboratory), delivered the third "Edward Williams" Lecture, his title being "Physical Factors in the Casting of Metals." This is printed on page 505.

Vote of Thanks

MR. J. E. HURST (Past-President), proposing a vote of thanks to Dr. Desch, said that the subject was peculiarly interesting to foundrymen. The value of the "Edward Williams" Lecture lay in the fact that specialists in particular branches of investigation work and in various sections of industry put forward up-to-date knowledge and surveyed all the work with which they were concerned. Inasmuch as the individual members of the Institute were operating in every branch of the foundry industry and of necessity became specialists in their particular branches, the opportunity which the "Edward Williams" Lecture afforded was very welcome to them.

One of the allegations by practical men against the metallurgist in the past was that he had been very academic and tended to deal with academic subjects. The lecture by Dr. Desch, however, would demonstrate very clearly that that allegation had absolutely no justification in fact. In recent years there had been a sort of reorientation of the attitude of metallurgists in investigation work and they tended to study subjects in connection with the casting and working of metals; the practical man might regard that as a victory for the attitude he had expressed in the past.

It seemed that Dr. Desch had wandered about among the various metals in a delightfully carefree manner; steel, cast iron, brass, bronze, gold, silver, platinum and gallium and others of the rarer metals had come within the purview of his lecture. It seemed that the reorientation of the attitude of metallurgists during recent years might be tending to break down the old-established divisions which had arisen in metallurgical study. Mr. Hurst had in mind the broad division of ferrous and non-ferrous metallurgy. It would appear that in the modern study of metals, divisions based on composition were fast disappearing.

The vote of thanks was seconded by MR. H. WINTERTON and carried with acclamation. DR. DESCH briefly responded.

Annual Banquet

A very large number of distinguished guests and members attended the annual banquet, which was held at Bemrose School, Derby, on Wednesday, June 9. The modern school buildings provided an admirable setting for such a function, and the floodlighting of the buildings added considerably to their attraction.

The President and Mrs. Bigg received the members and their guests before dinner. The company included the Worshipful the Mayor of Derby (Councillor Mrs. Petty), Mr. A. Hutchinson (President, Iron and Steel Institute), Mr. W. R. Barclay (President, Institute of Metals), Sir J. Arthur Aiton and Lady Aiton, Mr. H. Winterton (Immediate Past-President of the Institute of British Foundrymen) and Mrs. Winterton, Mr. J. Hepworth, M.P. (Senior Vice-President) and Mrs. Hepworth, Mr. W. B. Lake (Junior Vice-President) and Mrs. Lake, Mr. E. J. Fox, Mr. F. D. Ley (Chairman of the Reception Commitee), Mrs. F. E. Russell, Mr. W. Allan Reid, M.P. (Senior M.P. for Derby) and Mrs. Reid, Mr. S. H. Russell (hon. treasurer and Past-President of the Institute) and Mrs. Russell, Mr. C. Murray (President, Derby Chamber of Commerce) and Mrs. Murray, Dr. C. H. Desch, F.R.S. (head of the department of metallurgy, National Physical Laboratory), Dr. W. A. Richardson (Principal, Derby Technical College) and Mrs. Richardson, Mr. A. C. Turner (President, Foundry Trades' Equipment and Supplies Association), Mr. J. W. Gardom (Convener of the Institute's Technical Committee), Mr. Barrington Hooper (managing director, FOUNDRY TRADE JOURNAL), whilst other Past-Presidents present included Mr. F. J. Cook, Mr. John Cameron, Mr. V. C. Faulkner, Mr. V. Stobie, Mr. R. Stubbs and Mr. J. E. Hurst.

The Toasts

The loyal toast having been honoured, MR. ALFRED HUTCHINSON, M.A. (President of the Iron and Steel Institute), proposed success and prosperity to the Institute of British Foundrymen. It was a pleasure to be present, he said, first in his personal capacity, and also as President of the Iron and Steel Institute, which, as the oldest of the Institutes existing for the furtherance of research in the iron and steel trade, considered it to be a responsibility as well as a pleasure to encourage all allied bodies connected with the various branches of the industry as a whole.

A further personal reason why he was glad to be entrusted with the toast was that, though he was never a foundryman, the first ten or fifteen years of his business life were spent on a blast-furnace plant and the greater part of the pig-iron produced there was consumed in foundries. His particular job was to visit customers and clear up any complaints as to the quality of the iron supplied, a task which had afforded him ample opportunity to see how foundries were run. In those days he had found them to be run mainly on rule-of-thumb lines, the practical management being largely in the hands of foremen with little technical knowledge of chemistry or of the importance of sulphur and silicon contents or of the uses of fluxes in the cupola. In one instance within his memory the only flux was blast-furnace slag from the slag heaps of the neighbouring blast-furnace plant! There was, of course, a general belief in the appearance of the pig-iron on fracture as an indication of its suitability for the light castings or heavy pipes made; but he could recall only one works—and that was making a speciality—at which a chemist was employed at that time, and there they had confided to him that the employment of a chemist saved them at least 2s. 6d. per ton on the cost of their pig-iron mixture! Microscopic examination was unknown, and a macroscopic examination of a fracture had often led to curious inferences. In one case a foreman had complained of the poor quality of the pig-iron due to the use of mill cinder in its manufacture. When Mr. Hutchinson had pointed out that not an ounce of mill cinder was used in the blast furnace, the foreman had scoffed, and, taking out a pair of large brass-rimmed spectacles, had said "Why, man, I can see the mill cinder in the pig."

Institute Creates New Outlook

As the darkness of ignorance had prevailed in those early days, the dawn was at hand, and the sunrise had taken the form of the foundation of the Institute of British Foundrymen. It had in view the very worthy objects to initiate, conduct and supervise researches into the science and technology of the art of metal and alloy production, casting and working; to organise the technical education of the workers and to collect and distribute information on the art and science of foundry work. In so doing, it had paid due attention to the need for research and inquiry on the scientific matters connected with all real progress in industry. All foundry work was based on truly chemical and physical laws, and the chemical investigation as to the value of metallic and non-metallic contents in the substances used—not only in the pig-iron, but also in the coke, flux and casting sand—must be scientifically pursued and thoroughly understood if we were to improve quality and reduce costs. Only the trained scientific man could carry out such work. Therefore, the chemist had come into his own, and the result of such scientific work had produced little short of revolution in foundry practice. Foundry mixtures, by analysis in contrast to the old rule-of-thumb methods, had given better castings in every sense, improved quality and increased strength.

It was not only in the quality of the finished casting that improvement had taken place. New mixtures of iron and non-ferrous alloys had been produced, never dreamed of in his early years in the industry. However, he did not wish to leave the impression of having given credit to the chemist alone; it was much more than a matter of pure chemical research. The practical bearing on the day-to-day work in the foundry, on the structure of the cupola, the lay-out of the whole works and the mechanisation of the works as a whole, indeed, the truly scientific management of the whole works, had resulted from the advance of our technical knowledge. One of the chief contributions to the transformation from the old to the up-to-date foundry had been the good work of the Institute. The awakening to the value of scientific knowledge had become contagious. Managers and directors alike had become aware of the value of the interchange of knowledge, of discussions at regular meetings of the Institute of matters so vital to progress. Further, the Institute organised the spread of knowledge and technical efficiency. Papers were read and discussed by its members and by members of similar societies which had sprung into existence in other foundry centres. The belief in secret mixtures and secret nostrums had gone; the Institute had sounded the death knell of such old-fashioned methods. Mutual discussions of improved methods, mutual interest in every kind of technical advance, interest in the other fellow's method of attacking problems and free visits to each others' works were all to the good.

Utilising Existing Resources

Having paid tribute to the officials of the Institute for the successful development of its work, Mr. Hutchinson reminded the members, and particularly the younger members, that it was their job, just as much as that of the secretary or President, to ensure its success. They could do so by attending meetings and by cultivating the habit of taking part in the discussions, for a poor discussion on a Paper was a sorry return for the author's trouble in preparing it; by noting every point of technical improvement and efficiency as they moved about their works and other works; by keeping themselves well posted in the literature of the industry, and, when asked to contribute a Paper to the Institute's Proceedings, by accepting the invitation, be that Paper very short.

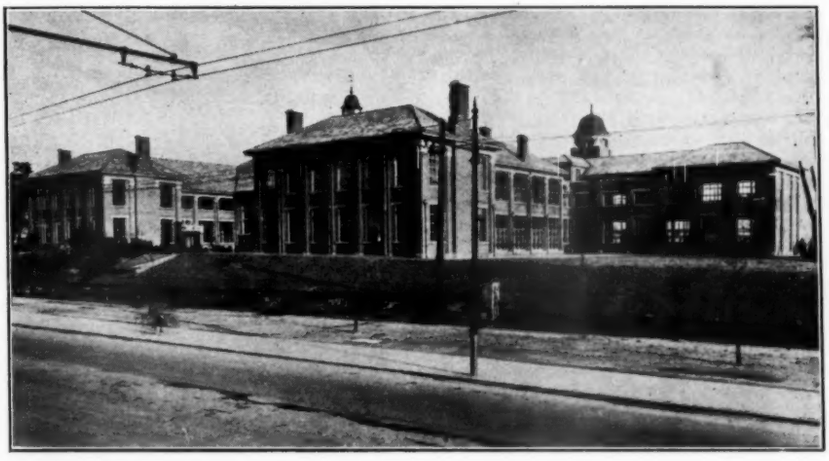
The local bodies provided the nursery for the great national institutes, such as the Iron and Steel Institute. It was to the continued success of a body such as the Institute of British Foundrymen, having many local branches, that one must look for real progress in the management and development of the works in which the membership were engaged. Mr. Hutchinson coupled with the toast the name of Mr. Bigg, the President of the Institute.

Wider Dissemination and Use of Knowledge Necessary

The PRESIDENT, on rising to respond to the toast, was received with prolonged applause. It was a source of great pleasure, he said, to hear the Institute referred to in so complimentary a manner by the President of a kindred body of such eminence as the Iron and Steel Institute, and it was a source of pride that the achievements of the I.B.F. were such as to merit fully the high praise that was bestowed upon it. It was a fact that no voluntary organisation had ever contributed more to the progress of an industry than the Institute had made to the progress of the foundry industry—and it was equally true to say that no industry was more in need of such contributions than was the foundry industry! He never hesitated to claim that the Institute was doing a tremendous amount of vital work in collecting and distributing knowledge to the industry. A professor at one of our universities had suggested recently that we were suffering from a surfeit of knowledge, and had said that our problem lay in bridging what he had called the ever-widening gulf between the specialised knowledge of the expert and the profound ignorance of the ordinary man. The President was not altogether in agreement, however, with the idea that we possessed too much knowledge, for we could not have too much. Rather did the trouble lay in either the non-application or the wrong application of the knowledge that we possessed. He emphasised, however, the latter part of the professor's remarks, with reference to the gulf between the knowledge of the expert and the ignorance of the ordinary man, and said that observation would convince us that to a degree that gulf was exemplified in the foundry industry. A tremendous amount of knowledge had been acquired, but it was in all too few hands; more experts were wanted in the application of knowledge. Many of our experts expended all their energies in the acquisition of knowledge; its application was equally important, however, and the guidance of the distribution and application of our expert knowledge should surely be one of the chief tasks of the Institute. The foundryman had no use for "knowledge done up in bundles," but wanted it in a readily applicable form. To the foundry industry the value of knowledge could be assessed only by reference to saleable castings.

The Institute, he continued, catered for the whole industry—from the man working on the floor to the technician and the executive, right up to the managing director. That wide range of membership, with its consequent variety of thought and expression, formed an ideal medium for bridging the gulf referred to, in order to enable the knowledge of the expert to be distributed and applied in the industry. Because of that, no single individual or firm in the industry could ignore the Institute's claims to their support.

Although it was time to consider "shutting off the blast," said the President, there remained still one charge to come down; it was a charge made up of 50 per cent. appreciation and 50 per cent. gratitude, which he hoped resulted in a close homogeneous mixture of good-will. That was the prelude to his expression of appreciation and gratitude to all who had contributed to the successful Derby conference. The generous response of so many friends to the appeals made for the "sinews of war," and the hospitality and assistance in many ways rendered by The Mayor and her colleagues in the Corporation, placed every member of the Institute under a deep sense of obligation to Derby. He paid a personal tribute to Mr. B. Gale for his help and guidance; to the many firms whose works were visited, for the splendid facilities and hospitality they had provided; to Dr. Richardson and his staff at the Technical College; to Mr. T. Makemson, the Institute's general secretary; to Mr. S. H. Russell, the convention "Chancellor of the Exchequer"; and to the East Midlands Branch. He was indeed proud of that Branch, and did not know what the Institute would do without it! The members of the Branch had thrown themselves into the work of organising the Conference with a readiness and ability which could have left no doubt as to their ultimate success. The bulk of the work had fallen on the shoulders of the Branch Secretary, Mr. B. Gale, who had done his job with a quiet efficiency which had won the admiration of all.



THE BEMROSE SCHOOL, WHERE THE MAYOR'S RECEPTION AND THE BANQUET WERE HELD.

A Presentation to Mrs. Winterton

On behalf of the Past-Presidents of the Institute, who appreciated the self-sacrifices made by the wife of a President during his year of office, MR. BIGG presented to Mrs. Winterton a Crown Derby tea service as a tribute to the charming and gracious manner in which she had supported her husband, Mr. Harry Winterton, during his period of office as President.

The presentation was made amid the cheers of the company; and MRS. WINTERTON, expressing her thanks, voiced the hope that many of her friends in the Institute would visit her and share the joy of using the gift.

The Borough of Derby

MR. J. HEPWORTH, M.P. (Senior Vice-President of the Institute), proposing "The Borough and Trade of Derby," said it was both a privilege and a pleasure to do so, particularly because the hospitality and kindness extended to the Institute had been *par excellence*. The management of the Borough, he said, stood out in regard to its social and educational facilities; and the beautiful building in which the Institute's banquet was being held provided ample evidence of the care which was devoted to the education of the youth of the Borough. That was to be expected, of course, where there was a lady at the head of affairs, as was the case in Derby.

The people of the north, he said jocularly, had never looked upon Derby as an industrial town! But in whatever industrial activity it had undertaken, whatever speciality it had decided to make, it had excelled beyond the wildest dreams of the imagination. The name of "Derby" was synonymous with "engines," not only railway engines, but also aero and motor car engines. Derby also catered for the more artistic side of industry, as evidenced by its productions of pottery; everyone liked to possess Crown Derby china—when they could afford it—and they usually placed it in cabinets for their friends to admire.

On the whole, therefore, the citizens of the Borough had every reason to be proud of their industry and of the way in which the Borough was managed. He wished the town continued prosperity, and coupled the toast with the names of the Mayor and Sir Arthur Aiton.

THE WORSHIPFUL THE MAYOR OF DERBY (Councillor Mrs. Petty, J.P.), who received a great ovation, responded on behalf of the Borough. Derby, she said, was one of those fortunate cities which had developed a variety of industries—and if some of the hard-headed gentlemen of other shires had been as far-sighted in the past as had the people of Derby, they might have had less problems to face in their own neighbourhoods! However, the response on behalf of the industrial life of Derby could well be left in the hands of Sir Arthur Aiton.

Derby had a definite history from the days of the Roman occupation. It had its "Little Chester," the very name of which indicated Roman occupation, and in the caverns of Derbyshire there were many traces of pre-historic man. The Mayor also commented on the part played by the Saxons, the Normans and the Danes in Derby's history, and pointed out that the Danes had chosen the name of "Derby." As a borough, Derby had a history covering a period of 1,000 years at least. A distinctive feature with regard to Derby was the fact that every one of its citizens had two Parliamentary votes; that state of affairs had continued since the 13th century, a record of which the city was justly proud. Again, it was the first city outside the city of London to provide a domestic water supply. It was provided by a local engineer who had helped many other towns in a similar manner.

SIR J. ARTHUR AITON, responding on behalf of the trade of Derby, set out first, in a jocular manner, to dispel the ignorance which Mr. Hepworth had professed with regard to Derby. He recalled that, 30 years ago, when he was considering moving a small business out of London, he had received a letter from a gentleman who was in charge of the Borough Development Committee in Derby, asking if he had thought of coming to Derby. Sir Arthur had replied that he had not. The Development Officer, after writing seven foolscap pages about the wonders of Derby, had run him to earth and had persuaded him to come to Derby—and he had had no cause to repent. In supporting the Mayor's remark concerning the variety of industries in Derby, Sir Arthur said he had not come to Derby because he had wanted to come, but because he had been brought there; and if the people of some other districts had been so far-sighted as were the Derbians of those earlier days and had brought industries to their districts, they might have been in a better position than in fact they were.

As soon as he had come to Derby, he had started a foundry, which was only a portion of his business. Whenever space was required for some development, a little piece of the foundry was taken for the purpose. Eventually a stage was reached at which the firm were being abused concerning the condition of some of the goods they had turned out, and it was decided to close the wretched foundry. When a customer, who had been particularly strong in his criticism of the firm's products, was told of the decision to close the foundry, he had pointed out that he dealt with the firm because they did the whole of the work themselves and that, if they did not keep the foundry going, he would have to obtain his goods elsewhere. The decision was then taken to keep the foundry going, and, moreover, to run it on proper lines. They had got into touch with a man who had designed a really beautiful foundry—although the members of the Institute had not been fortunate enough to see it, owing to the ignorance of their President! (Laughter.) Plenty of room was provided, and everything in the foundry was quite up to date; but the ungrateful Scottish foreman had remarked, "I wonder how long I shall be allowed to keep it."!

Touching on the problem of training personnel, Sir Arthur said that if we were to continue to employ men who were little better than machine tenders, even though the foundries in which they were employed were beautifully designed and well managed and organised, we should lose the splendid skilled foundrymen of this country. Already it was difficult to secure their services, for we could not expect to raise such men by machine moulding. His firm's foundry had its own school, and Dr. Richardson and his staff at the Derby Technical College helped in the training of the men by the classes they had arranged. Though the scientific knowledge was absolutely necessary, the best would not be obtained from foundries if men were not trained to carry out the actual work or to make foundry work attractive to the better class of man it was desired to attract.

MR. S. H. RUSSELL (hon. treasurer and Past-President of the Institute) proposed "The Guests." It was impossible, he said, within the limited time at his disposal, to mention all the guests individually and to expound their virtues, because the guests and their virtues were numerous; and to attempt to generalise was equally unsatisfactory. However, he mentioned some of the guests particularly, assuring all that they were most cordially welcome and that their presence was greatly appreciated. He paid tributes to the Mayor and her colleagues, including the Corporation officials, who had made it possible for the Institute to hold its convention in Derby, and had placed the Bemrose School at the disposal of the Convention Committee; to the President of the Iron and Steel Institute (emphasising with great appreciation the co-operation between the Iron and Steel Institute, the Institute and the British Cast Iron Research Association); to the President of the Institute of Metals; to Dr. Desch, a representative of the National Physical Laboratory; to the Principal of the University College, Nottingham, and the Principals of the Technical Colleges in Derby, Leicester and Loughborough, emphasising the great debt which the East Midlands Branch of the Institute particularly owed to the education authorities of those towns; and to the Members of Parliament, heads of business, and the ladies. He coupled with the toast the names of Mr. W. R. Barclay (President of the Institute of Metals) and Mr. E. J. Fox, to whom he referred as one of the oldest and staunchest friends of the Institute.

MR. W. R. BARCLAY, O.B.E. (President, Institute of Metals), in his response, commented on the close interest between the Institute of Metals

MR. B. GALE
(Honorary Conference Secretary).

and the Institute in the work they were doing, and said he believed that the branch of metallurgy with which the Institute had been concerned had a more distinguished and honourable history than perhaps any other branch. It was difficult to discover just when foundry work had begun. It was surprising, and perhaps a little humiliating, that hundreds of years ago craftsmen were producing glorious works of art in metals. Craftsmanship was one of the concerns of the Institute which it must always place in the forefront. Both the practical and the scientific worker were essential to the industry, for the skilled workman and the skilled research worker could be successful only in the degree to which both sought to obey to the very utmost of their power the laws of nature.

MR. E. J. FOX took advantage of the late hour to scrap the speech he had intended to make (following the example of Mr. Barclay), and contented himself with an expression of thanks for the hospitality extended to the guests, and the hope that he would have the pleasure of welcoming many members of the Institute to the Stanton Ironworks on the following day. He claimed to be a foundryman, because his interests were occupied in re-melting 10,000 tons of iron per week, a quantity far in excess of that which was remelted by any other undertaking in the world.

Following the banquet, the members and their guests enjoyed dancing until a late hour.

SOCIAL EVENING AT ASSEMBLY ROOMS

On Thursday evening members and ladies were entertained by the East Midlands Branch at a social held at the Assembly Rooms, Derby. A concert party provided entertainment, and dancing was held throughout most of the evening.

During an interval in the proceedings, MR. C. W. BIGG (President) paid a tribute to the work of Mr. B. Gale, the Secretary of the Conference. Although many members of the Branch, he said, had contributed to the success of the Conference, on Mr. Gale had fallen the main burden, and the members of the East Midlands Branch were anxious to give to Mr. Gale some token of their appreciation.

Presentation to Mr. Gale

MR. H. BUNTING (retiring President of the East Midlands Branch), in presenting Mr. Gale with a cheque on behalf of the Branch, said that the gift was in no way a payment for services, but a tangible recognition of very valuable work.

MR. GALE, in responding, was received with loud applause. He briefly expressed his thanks, and voiced his appreciation of the co-operation he had received from the other members and officials of the Branch.

Excursion to Derbyshire Beauty Spots

On Friday about 100 members and ladies took part in an excursion through the beautiful scenery of Derbyshire. The party left Derby by motor-coaches and proceeded by way of Ashbourne and Longnor to Buxton, where luncheon was served at the Spa Hotel.

After luncheon, MR. BIGG (President) took the opportunity to propose that the sincere thanks of the members who had attended the Conference be tendered to the President and officers of the East Midlands Branch for the wonderful arrangements they had made for a most successful Conference.

MR. H. WINTERTON (immediate Past-President of the Institute) seconded the proposal, and as one of the visitors to Derby, spoke of the most hospitable manner in which the visitors had been received by the Mayor and Corporation, and by members of the East Midlands Branch.

MR. H. BUNTING, responding on behalf of the Branch, expressed the delight of the members of the Branch in having the opportunity to organise a Conference and in entertaining their colleagues from other districts.

In the afternoon the party continued their tour and proceeded via Bakewell to Matlock, where they were entertained to tea at the New Bath Hotel by the President and Mrs. Bigg.

MR. F. J. COOK (Past-President) expressed the thanks of the members to the President and Mrs. Bigg for their hospitality; MR. J. CAMERON (Past-President) seconded, and also took the opportunity to congratulate the East Midlands Branch and Mr. H. L. Peace and MR. A. E. Sanders on the very excellent souvenir booklet which had been issued.

MR. C. W. BIGG (President) replied.

The journey was afterwards resumed, the party arriving in Derby during the early evening.

New Furnaces at Scottish Steelworks

Two new furnaces are to be installed at the Hallside Works of the Steel Company of Scotland, Limited, at Newton, Cambuslang. The company have asked Lanark County Council for a supply of gas for one of the furnaces, stating that they intend to put down a large furnace and a small one. The former will be supplied with gas from the company's own plant, but it is desired that gas be supplied for the small one from the County Council gas undertaking.

The Third Edward Williams Lecture

Physical Factors in the Casting of Metals

By Dr. C. H. DESCH, F.R.S. (National Physical Laboratory)

Many physical properties are involved in the filling of a mould with liquid metal for the production of a casting. These factors vary greatly in their relative importance, and it has sometimes happened that an exaggerated significance has been attached to one or other of them. Laboratories in which metallurgical research is conducted are often asked to undertake exact measurements of certain physical properties of metals which exert only a minor influence on the quality of a casting, many practical foundrymen being under the impression that difficulties which they experience are connected with that particular property. The aim of this lecture is to review these factors, very briefly, and to indicate which are likely to deserve most attention. It should hardly be necessary to add that the skill of the foundrymen remains one of the most important factors, and it is not susceptible of quantitative expression.

"Flowing Power"

The first condition of obtaining a satisfactory casting is that the metal shall flow evenly into the mould, and shall fill it completely before such freezing occurs as to offer an obstruction to its further flow. This property has been called by the French metallurgists "coulabilité," a word which is slightly clumsy, but far less so than its uncouth English rendering "castability." I am glad to learn that it is not popular amongst foundrymen, and that we may be able to avoid its use. "Fluidity," which is often preferred, has the disadvantage that it has a specific physical meaning, as the reciprocal of the viscosity, and although it has been proposed to abandon it in that sense, its old associations stand in the way of its adoption. I prefer "flowing power," which is not too cumbrous and does not carry with it any suggestion of being an exact physical constant. The figure used to express the flowing power will depend on the apparatus employed for the experiment, and on many conditions of casting. It is the resultant of a number of physical factors which are capable of being expressed quantitatively, but it remains an empirical quantity. Much has been done in recent years to standardise the methods of determining the flowing power, and reference should be made to the Second Report of the Steel Castings Committee issued last year by the Iron and Steel Institute, and especially to the excellent survey of the whole subject by Dr. R. H. Greaves.[1]

Roughly, the values obtained for the flowing power will depend on two kinds of factors, one set depending on the conditions of the experiment, including the form, material and surface of the mould, the casting head, and the degree of superheating of the metal before pouring, and the other involving the properties of the metal or alloy. This second set includes viscosity, surface tension, gas content, formation of surface films, as of oxide or nitride, the range over which solidification takes place, change of volume during solidification, and crystal thrust. There are other factors which affect the quality of the resulting casting, although not among those which govern the flowing power. These include the contraction in the solid state; the strength at temperatures near to the freezing point; the liability to segregation; and the tendency to form small or large crystal grains, the last being dependent in many instances on the previous history of the metal, that is, on the highest temperature to which it was heated before cooling to the temperature at which it was poured.

Experimental Conditions

It is mainly the second group of conditions with which this lecture is concerned, but a few words must be said about the first group—the conditions of the experiment. The flowing power is now most often determined by casting in a spiral mould, and measuring the total length of mould which is filled by solid metal, the conditions of casting having been fixed beforehand.

DR. C. H. DESCH, F.R.S.

This device was first introduced in Japan,[2] having been developed from the simple wedge test of West, and has been adopted by many later workers, for cast iron, non-ferrous metals and alloys, and steel.[3] Sand moulds are commonly used, but iron moulds have also been employed. A plumbago facing gives a longer casting than when unfaced sand is used, and, when the conditions are such as to give a long casting, a dry-sand mould gives, as might be expected, a greater length than one of green sand. Increasing the degree of superheat naturally increases the flowing power, as the metal can travel farther before it has cooled to the freezing point, and this increase with temperature is practically linear.

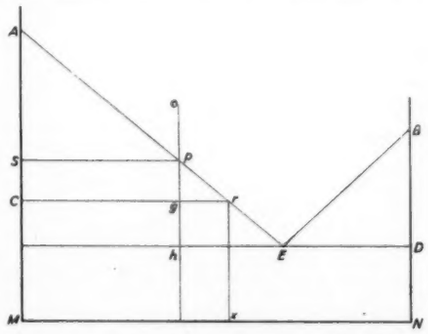


FIG. 1.—TYPICAL CONSTITUTIONAL DIAGRAM OF A SINGLE-EUTECTIC FORMING ALLOY.

Viscosity

The first of the physical properties mentioned, that of viscosity, has been credited with a far greater influence on the flowing power than it actually possesses. In reality, the viscosity of metals is very low, the kinematic viscosity being less than that of water in all the examples investigated, and as it changes only slightly with change of temperature, it is really a negligible factor in casting. How, then, has the very general belief arisen that metals differ widely in viscosity, and that difficulty in flowing is caused by increased viscosity, which varies rapidly with the temperature? Probably because a metal which is flowing badly often appears to be viscous or treacly, when the effect is actually due to the surface tension of a thin and tough film, or to the presence of much gas in the form of minute bubbles, producing a foam. The "head" on a glass of beer flows with much more difficulty than the mass of the liquid, owing to surface tension in the innumerable thin films which separate the bubbles. Viscosity of the liquid metal could only become important if the channel to be filled were a fine capillary, and even then its influence would be outweighed by other factors.

It has been urged that, although metals are very fluid above their melting point, yet in the interval between the beginning of freezing and the solidification of the last eutectic or other fusible portion, there is a sudden and even enormous increase in the viscosity. This is quite contrary to what is known of viscosity, and there is no reason to suspect any such discontinuous change. It is true that an experiment to determine the viscosity by one of the usual methods is likely to be interfered with by the presence of crystals, blocking the channel if the method be one of flow through a capillary, or adhering to the surface of the pendulum or cylinder if one of the torsional methods be used, but such an effect has nothing to do with true viscosity. The unlikelihood of any real increase during freezing may be shown by very simple reasoning. Consider a system of alloys forming a single eutectic (Fig. 1). A liquid alloy *o* on cooling begins to freeze at the temperature *p*, depositing crystals of the metal A. By the time that the temperature has fallen to *g*, the alloy consists of crystals of A with a liquid of composition *r*, but this liquid, taken by itself, has a viscosity which lies between those of the metals A and B, this being the general rule for alloys.

The diminished flowing power is not, then, due to any increase of viscosity during the process of freezing (in metallographic terms, in the interval between the liquidus and the solidus) but to some other cause. The most obvious is obstruction of the channel by the growing crystals, and this is the real reason. If the freezing of the alloy were to begin by the formation of small crystals suspended freely in the liquid, there would be some increase in viscosity, as suspended particles do hinder flow, and a liquid in which more than a small proportion of particles is suspended, if tested in a viscometer, will give a higher value than the same liquid free from solid particles. Actually, such a precipitation of free crystals as a shower is only known to occur when a liquid is strongly undercooled, whilst in most instances the undercooling of metals and alloys is limited to a few degrees at most.

Flow after Initial Solidification

I am indebted to my colleague, Mr. V. H. Stott, for pointing out that, in the experiments conducted with a cast iron spiral mould by Portevin and Bastien,[4] the curves showing the lengths of casting with different degrees of superheating for a number of metals of low melting point indicate that a considerable portion of the total length must be due to flow occurring after solidification has begun. When the interior of the mould has been coated with crystals of

solid metal, the volume of liquid which traverses the constricted channel in unit time, being proportional to the fourth power of the radius, will fall off very rapidly as the thickness of the solid layer increases. Moreover, should the crystals formed be dendritic, projecting into the interior, they will have a greater effect in retarding the flow than if they were simple polyhedra. Pure metals and solid solutions crystallise mainly as dendrites, whilst intermetallic compounds are more often polyhedral, and eutectics tend to form spherulitic masses, which probably offer the least resistance of all. There is, however, another reason, discussed later, why eutectics give longer castings than alloys differing from them somewhat in composition, which is of even greater importance.

Viscosity Measurements

There are two main methods of measuring the viscosity of a liquid metal: by allowing it to flow under a constant head through a capillary tube, and by using some form of torsional pendulum. The first can only be applied to metals of fairly low melting point, the capillary being of glass or silica. Many measurements of this kind have been made. In the second, which may be used even up to very high temperatures, a disc or cylinder is suspended in the molten metal, and on setting it into torsional oscillation, the damping in successive swings is measured, the "logarithmic decrement" being a measure of the viscosity. Using a horizontal disc of fired alumina, suspended by a phosphor-bronze wire, the viscosity of molten tin was determined at the National Physical Laboratory over a range of temperature from 240 to 800 deg. C.[5] No discontinuity in the viscosity curve could be found a few degrees above the melting point. In the apparatus used at Aachen for cast iron,[6] suspended cylinders were used as pendulums, and the viscosity curves showed an abrupt change of direction, corresponding with the deposition of the first crystals. The viscosity was diminished by increasing the carbon or the phosphorus, but increased by sulphur, probably on account of the separation of sulphide particles.

In a modification of the pendulum method, two concentric cylinders are used, one of which is stationary, while the other can be rotated, and the liquid occupies the annular space between the two. This method has been much used in the scientific study of steady and turbulent flow in liquids.[7] It presents practical difficulties when applied to metals, but such an arrangement has been used in the study of cast iron, with results similar to those obtained with the solid pendulum. Grey and white cast iron were found to behave very similarly.

The conclusion is that the viscosity of metals plays only a minor part in their casting behaviour, and that the effects which have been attributed to viscosity are mainly due to other causes. It does not seem necessary, therefore, to undertake difficult and refined laboratory measurements of this property on behalf of the foundry industry, although determinations are needed for certain theoretical purposes.

Surface Tension

The surface tension of a metal or alloy is another physical property which may affect the casting quality. Molten metals do not wet their moulds, unless in such exceptional cases as mercury or molten tin in a mould of tinned copper, which may be neglected. In a narrow channel, therefore, there is a resistance to the flow of the metal owing to its surface tension, but this effect becomes less marked as the diameter of the passage is increased. Actually, the amount of the resistance so produced is small in most castings, provided that the metal has a clean surface, a condition which is not always fulfilled, as mentioned below. As a rough indication, values given in Table I may be taken for the surface tensions of some of the common metals, at temperatures not much above their melting points.[8]

Metals of high melting point thus have a higher surface tension than the easily fusible metals. From the figures for the two alloys of iron and carbon, it appears that steel has a higher surface tension than cast iron, and pure iron would probably give a still higher figure. The surface tension of water at 20 deg. C. is only 81, so that the values for the metals are relatively high.

The surface tension diminishes as a rule with increasing temperature, but cadmium and copper are anomalous in this respect, the value increasing up to a maximum and falling again as the temperature is still further raised.

There is at present no satisfactory means of determining the surface tension of a solid. It seems likely, however, that the metals will arrange themselves in about the same relative order in the solid state as in the liquid, and this supposition accords with certain interesting features of their crystallisation, which have an indirect bearing on casting conditions. Under the influence of surface tension, a body tends to assume the form which gives it the smallest possible surface, so that an isolated drop of a liquid becomes spherical. This is true of solids as well as liquids, but the effect is only perceptible at temperatures near to the melting point. An examination of microsections of alloys containing primary crystals embedded in a eutectic will show that metals with a high surface tension, such as copper, form crystals with much rounded outlines, whilst when the metal has a low surface tension, such as antimony, it forms dendrites with sharp angles. Gold gives highly rounded forms, and even below the melting point, sharp-angled crystals of gold, prepared by etching, become rounded if heated.[9] When the first shell of crystals forms at the surface between the metal and the mould, it will make a difference to the flow whether the crystals so produced are angular or rounded, as the rounded forms may be expected to offer less resistance, although it cannot be said that there is any definite evidence on this point. Some experiments would be worth making. Surface tension also determines to a great extent the forms of the crystal grains in a casting, and the liability of some alloys to intercrystalline fracture is connected with changes in the surface tension at the grain boundaries, the causes of which are now the object of study at the National Physical Laboratory.

REFERENCES

1 R. H. Greaves, Second Report of Steel Castings Committee, Iron and Steel Inst., 1936.
2 D. Saito and K. Hayashi, Mem. Coll. Eng. Kyoto, 1919, **2**, 83.
3 Iron and Steel Inst., Bibliography No. 1, 1936.
4 A. Portevin and P. Bastien, "Comptes Rendus," 1932, **194**, 850.
5 V. H. Stott, Proc. Phys. Soc., 1933, **45**, 530.
6 P. Oberhoffer and A. Wimmer, Stahl. u. Eisen, 1925, **45**, 969.
7 G. I. Taylor, Phil. Trans., 1922, **233** A, 289.
8 L. L. Bircumshaw, Phil. Mag., 1934, (vii), **17**, 181.
9 C. H. Desch, "Chemistry of Solids" (Ithaca), 1934, 55.
10 A. Portevin and P. Bastien, Proc. Inst. Brit. Foundrymen, 1936, **29**, 88.
11 E. E. Schumacher, J. Amer. Chem. Soc., 1923, **45**, 2255.
12 D. Damianos, Physikal. Z., 1925, **27**, 289.
13 G. D. Preston and L. L. Bircumshaw, Phil. Mag., 1935, (vii), **19**, 160.
14 L. Guillet and A. Portevin, "Comptes Rendus," 1926, **183**, 634.
15 A. Portevin and P. Bastien, "Comptes Rendus," 1932, **194**, 850.
16 J. H. Andrew, R. T. Percival and G. T. C. Bottomley, 2nd Rep. Steel Castings Committee, 1936.
17 A. Portevin and P. Bastien, J. Inst. Metals, 1934, i, 45.
18 Thyssen and Perin, Amer. Foundrymen's Assoc., 1934.
19 M. Toepler, Ann. Physik., 1894, **53**, 343, and many others.
20 V. H. Stott, J. Inst. Metals, 1936, **59**, 73.
21 H. Endo, J. Inst. Metals, 1923, ii, 121; Y. Matuyama, Sci. Rep. Tohoku Univ., 1928, **17**, 1.
22 F. Sauerwald, Z. anorg. Chem., 1924, **135**, 255, and later Papers.
23 C. J. Smith, Proc. Roy. Soc., 1927, **115** A, 554.
24 W. E. Goodrich, Trans. Faraday Soc., 1929, **25**, 531.
25 C. H. Desch and B. S. Smith, J. Iron and Steel Inst., 1929, i, 358.
26 W. Schmidt, Ergebn. tech. Röntgenkunde, 1933, **3**, 194.
27 D. W. Berlin, Carnegie Schol. Mem. Iron and Steel Inst., 1926, **15**, 1.
28 G. Ericson, *ibid.*, 1934, **23**, 13.
29 C. H. Desch, J. Inst. Metals, 1914, i, 57.
30 T. Turner and M. T. Murray, *ibid.*, 1909, ii, 98.
31 R. Förg, Intern. Z. Metallogr., 1916, **8**, 68.

TABLE I.—*Surface Tension of Some Common Metals.*

Metal.	Temp., deg. C.	Surface tension, dynes per cm.
Antimony	640	350
Bismuth	269	378
Lead	327	452
Mercury	20	465
Tin	232	526
Cadmium	320	630
Zinc	419	758
Silver	998	923
Copper	1,131	1,103
Gold	1,120	1,128
Iron (2.2 per cent. C) ..	1,420	1,500
Iron (3.9 per cent. C) ..	1,300	1,150

The temperatures from antimony to zinc are the melting points, and the measurements were made at a slightly higher temperature; for the remaining metals the temperature of the experiment is given.

Searching Power

The effect of surface tension in determining the "searching power," or degree of penetration of the molten metal into the sand of the mould, has been very fully dealt with by Prof. Portevin and Dr. Bastien in their Paper contributed to this Institute last year.[10] The condition here is one of penetration into very narrow capillary spaces, and the presence of surface films, discussed below, assumes great importance.

If gases are being continually evolved from a metal during casting, its flowing properties may be influenced in more than one way. A lively evolution of small bubbles, causing an effervescence, as in casting a certain class of steel, may appear to make the metal more fluid, but the effect is probably only apparent, and in a narrow channel there will certainly be an increased resistance to flow. One difficulty in applying data as to surface tension to the case of a metal flowing in a channel arises from the fact that the metal is often not in actual contact with the mould, but is separated from it by a thin layer of gas, either issuing from the metal or arising from the material of the mould. The "interfacial tension" between metal and solid is then altered, perhaps considerably. Experiments by Schumacher indicate that if glass could be completely freed from its adhering layer of gas, it would be wetted by mercury.[11]

Surface Film Effects

A surface film of a foreign substance affects the flowing power far more than any possible variation in the true viscosity or in the surface tension. Aluminium provides a striking example. On exposure to air, aluminium forms immediately a thin layer of the oxide, alumina. This film is very tenacious. In the Paper contributed to this Institute last year by Prof. Portevin and Dr. Bastien,[10] determinations of the apparent surface tension of oxidised and clean aluminium were described, the effect of the oxide film being to increase the value to nearly three times. This result is probably too low, as it is difficult to obtain a surface of molten aluminium which is not covered by a very thin film of oxide. That film has such strength that it is possible to melt a long, freely suspended loop of aluminium wire by passing an electric current through it, without rupture, the skin being strong enough to retain the weight of the molten metal. Using this method quantitatively, Portevin and Bastien were able to show that the oxide skin had a tensile strength of 2 kg. per sq. mm. (1.3 tons per sq. in.). Aluminium and magnesium can form skins of nitride as well as of oxide.

A short lead wire could be heated in the same way, either by passing an electric current or by enclosing in a heated tube, to above its melting point without fracture if in air, being sustained by its oxide coating, but in nitrogen it broke directly the melting point was reached.[12]

This property of aluminium also affects alloys in which it is present. The difficulty of casting aluminium bronze (the copper alloy containing

8 to 10 per cent. of aluminium) is caused by the formation of such a tough skin, which hinders pouring and, by becoming broken into fragments, is entangled in the metal, making a dirty casting. Brass forms a much less tenacious film during pouring, and the zinc oxide which is produced breaks up very readily, again causing defects. A brass containing aluminium forms a skin of the tough kind, so that a surface of such an alloy in the crucible shows little evaporation of zinc unless it be stirred, when the protective film is broken, and a puff of vapour escapes.

When the oxide is soluble in the molten metal, no film is formed, so that copper, iron and nickel pour in a clean stream, although they may contain solid matter in suspension. Moreover, if two of the constituents of the alloy can form a mixture of oxides with a lower melting point than that of the alloy itself, the surface film will be liquid instead of solid. This, of course, is the case when a flux or a deoxidiser, such as phosphorus, has been added which reduces the melting point of the oxide mixture sufficiently. The conditions of oxidation of some of the metals have been the object of study at the National Physical Laboratory. The film formed on molten tin, for example, may be either smooth and compact, or bulky and corrugated, the bulky form allowing oxidation to go on rapidly, whilst the other is protective.[13] It was found that the difference corresponded with a difference in the arrangement of the minute crystals of the oxide, the loose film having the crystals arranged at random, whilst the compact skin had a definite "preferred orientation." This difference, which assumes great importance in connection with the oxide films on solid metals, deserves further study in the case of molten metals. The orientation was determined by the method of electron diffraction.

Magnesium is another metal which forms a troublesome oxide skin, which must be removed by a suitable flux if clean castings are to be obtained. According to Dr. Greaves, an overoxidised steel which has been killed with aluminium is also liable to be contaminated by fragments of an alumina skin which become detached from the surface and entangled in the stream. It is known that some of the other deoxidisers used in the war as substitutes for manganese gave trouble from this cause. Such suspended particles not only interfere with the free flow, but give rise to inclusions in the solid metal, injuring its quality.

Freezing Range

A pure metal freezes at a constant temperature, but in most alloys the process extends over a range, and the extent of this range is of importance in determining the flowing power. Eutectic alloys, and such as occupy a minimum on the freezing-point curve, as in the alloys of copper and gold, freeze at a constant temperature, like pure metals. Guillet and Portevin[14] showed that in the alloys of tin with lead and with bismuth the curves showing the variation of flowing power with composition had maxima at the eutectic compositions, whilst there was no such indication in the curves of viscosity, or of its reciprocal, fluidity in the scientific sense. Portevin and Bastien[15] concluded, from a study of a number of alloys of low melting point, that the flowing power varies (in any one system of alloys) inversely as the solidification interval, and is thus greatest for pure metals and eutectics. This has been confirmed by other workers. The statement that "It has been assumed in the past that the position of the liquidus on the temperature axis for any particular alloy gives the point where that alloy possesses zero fluidity,"[16] is clearly incorrect, as many investigators have shown that flow takes place below that temperature, and the results of Prof. Andrew's experiments confirm their conclusions as to the influence of the temperature range of solidification. The very small number of points used in the construction of the curves in the Paper referred to do not justify the deductions as to the effect of the peritectic transformation in the alloys of iron and carbon.

Ternary Alloys

Experiments have been extended to ternary alloys,[17] and it is found, as might have been expected, that a ternary eutectic, which freezes at a constant temperature, has the greatest flowing power of all the alloys included in the system. Once more the flowing power is (roughly) inversely proportional to the range of temperature over which solidification takes place. The conclusions are in accord with the observed behaviour of phosphoric cast iron,[18] which is well known to be more fluid than a similar iron containing less phosphorus.

The reason is to be found in the separation of the primary crystals, which form a shell, obstructing the flow. As mentioned above, the habit of the crystals affects the resistance which they offer, and alloys with a long freezing range mostly deposit primary crystals of the dendritic type. The effect is complicated by the existence of crystal thrust, referred to later.

Volume Change on Solidification

The methods of determining the total shrinkage of alloys used for castings are well known, and it is not proposed to review them here. It

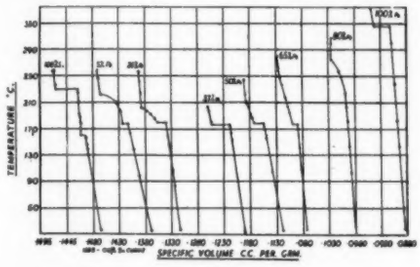


FIG. 2.—SPECIFIC VOLUME/TEMPERATURE CURVES OF LEAD/TIN ALLOYS.

is, however, of importance to know the actual change of volume during the process of freezing, and this subject falls next to be considered. Several methods have been employed. The simplest is that of the dilatometer used in measuring the coefficients of expansion of liquids, a rigid vessel having a neck in which the level of the liquid can be read. For the examination of the freezing range, special care has to be taken that solidification takes place regularly from the bottom upwards. This method was used for metals by most of the older workers.[19] Corrections have to be made for the change of volume of the mould with temperature, and any internal cavities cause errors. Aluminium and some of its alloys were examined in this way, using electrical contacts to determine the level of the metal in the refractory vessel.[20] A second method consists in suspending the metal in a crucible from one arm of a balance, the crucible being immersed in a bath of a liquid of known density and coefficient of expansion, and measuring the displacement over a range of temperature.[21] This method, although it will give the total volume change satisfactorily, as shown by the results of Sauerwald,[22] suffers from the defect that there is a great lag of temperature between the bath and the metal, and thermal equilibrium is practically impossible of attainment. Thus, in one series of experiments, the sudden change of volume of antimony on freezing was recorded as 560 deg. C., whilst the freezing point of antimony is 631 deg. Using a balance in this way, it is not possible to use a stirrer to obtain equilibrium, and unknown temperature gradients exist in the system.

Mechanism of Freezing

In order to obtain a more complete picture of the process of freezing, experiments were undertaken in the writer's laboratory during his tenure of the chair at Sheffield University, to ensure that readings of volume were only made under conditions of thermal equilibrium. It was decided to use a differential method, and an apparatus was constructed[23] and afterwards improved and used for an extensive series of measurements of metals and alloys up to 450 deg. C.[24] The apparatus consists essentially of two similar bulbs of glass or silica, immersed side by side in a stirred bath of oil or fused salts so that they can be brought accurately to the same temperature, and communicating with a differential manometer. One of the bulbs contains a known quantity of the metal, the space above it being filled with nitrogen, whilst the other contains only nitrogen. The differences of expansion or contraction recorded by the manometer then correspond with the changes of volume of the metal. Many precautions are necessary to eliminate sources of error. To ensure clean specimens, it was found essential to melt the metal beforehand in a high-frequency induction furnace in a good vacuum, and while in that state to filter it through a fine capillary in order to remove any skin of oxide. Readings may be taken as slowly as is desired, the system being brought to a steady temperature before each adjustment of the manometer, so that thermal lag disappears completely. A few of the results obtained by Goodrich are shown in Fig. 2.

The advantage of this method is that it is possible to measure accurately the change of volume on freezing, distinguishing that part which corresponds with the separation of primary crystals from that due to the eutectic. The only appreciable error may arise from the production of small intercrystalline cavities owing to a part of the final contraction occurring after the mass of the crystals has become rigid, thus making the apparent contraction slightly too small, but the effect of this was found to be only slight.

In experiments involving a great lag of temperature, as when an alloy is suspended in a liquid without stirring, the measurements indicate a range of temperature of as much as 20 degrees over which the freezing of a pure metal occurs, the curves of expansion or contraction in the liquid and solid state being drawn, with an intermediate branch representing the freezing. With the method employed by Goodrich, readings in the solid and in the liquid state could be brought to only 0.2 degree C apart, and the temperature-volume curves of an alloy could be drawn with an accuracy equal to that of a thermal analysis, with the added advantage that as much time as was required to ensure equilibrium could always be allowed. The process is, however, tedious, as the taking of a complete curve occupies several days. Points were determined both with increasing and with falling temperature, and in irregular order, so as to eliminate any drift. The process of freezing proved to be quantitatively reversible.

Difficulties with Elevated Temperatures

There is no reason why this method should not be extended to higher temperatures, using silica or porcelain vessels. A special problem presents itself in the case, so important for the foundryman, of cast iron and steel. Gastight vessels for such high temperatures are not easy to construct, and so far the dilatometer method has not been used to determine the change of volume of these metals on solidification. The measurement of the contraction in the liquid state, however, is not so difficult. Using a molybdenum resistance furnace, and determining the level of the liquid surface by observing the reflection of a molybdenum wire lowered to make contact with it by a micrometer, it was found possible to make satisfactory measurements of the density of pure iron above its melting point.[25] Since the expansion of iron up to a temperature just below the melting point has been determined accurately by X-ray measurements of the lattice parameter,[26] the change of volume on freezing can be calculated. Values are given in Table II.

The density method just described also appeared to succeed with white cast iron, but as the results differed considerably from those obtained by other methods they are to be treated with reserve, the removal of carbon during the experiment by the reducing atmosphere (hydrogen + nitrogen) which has to be used, introducing an error.

In another method, also used for iron and steel,[27] the molten metal is enclosed in a U-tube of refractory material, enclosed in a furnace at constant temperature, whilst a similar U-tube containing mercury is kept at atmospheric temperature. By applying gas pressure to one limb of each U-tube, differences of level can be produced, and a measurement of these gives the ratios of the density of the molten iron and mercury. This method has the advantage of being independent of the coefficient of expansion of the tubes, but is difficult on account of the lack of refractory materials which are impervious to gases at such high temperatures.

Simplified Tests

Measurements have been made also using very simple means.[28] If a mass of metal, preferably spherical, be cooled quickly from the melting point, in such a way that a uniform solid crust is formed, the contraction during freezing will produce a hollow in the interior. In the subsequent cooling, the contraction of the hollow mass will be the same as if it were solid, and by determining the volume of the cavity when cold, the percentage contraction on freezing may be calculated. It has to be assumed that the mass retains its spherical shape, and there is usually some distortion. This is allowed for by measuring any obvious depression in the surface, but such a correction is not always easy, and the existence of distortion is responsible for the rather erratic results obtained. The method was, however, applied to iron, with specimens varying from the small shot produced by a free fall to masses of 200 grams. It was used by the same experimenter in a study of grey iron, and the results indicated that the expansion which all foundrymen know to occur takes place during freezing and not, as has sometimes been supposed, after solidification is complete, by a reaction in the solid state. Instead of a cavity in this instance, a drop of molten metal was formed, and was extruded during freezing, appearing on the surface.

This expansion is, of course, caused by the formation of graphite, which has a much larger specific volume than either the solution from which it is derived, or the carbide which takes its place in a white iron. This is a metal which would give very interesting results if it could be studied over a wide range of temperature in a dilatometer of the kind described above. The experimental difficulties would be considerable, but the work might be justified on account of its importance to the foundry industry.

A few of the most trustworthy results are shown in Table II. The only pure metals which expand on freezing are bismuth, antimony and gallium, and this exceptional property affects their alloys, neutralising the contraction due to the other metal, to an extent depending on the composition. Stott has shown how the contraction of an alloy may be calculated with fair accuracy from a knowledge of the behaviour of its component metals, remembering that the variation of specific volume with composition is not far from linear, both in the liquid and in the solid states.

Crystal Thrust

A factor which is commonly ignored is that of the thrust which may be exerted by growing crystals. An apparent expansion during solidification is sometimes observed when determinations of density show that the volume has actually diminished. The writer has summarised the history of the subject on an earlier occasion.[29] It will be enough to mention one familiar example. When plaster of paris is mixed with water in a test-tube, the mass seems to expand during setting, and the glass will burst. The volume after setting is, however, less than that of the original plaster plus that of the water. The effect is due to the crystals pushing against one another, and increasing the apparent volume, the resulting mass being porous. In the same way, with the modification of Keep's contraction apparatus employed by Prof. Turner, in which the metal is cast in a sand mould in the form of a T-shaped bar, one end of which is held by a fixed pin, whilst the other is attached to an extensometer, an expansion is often observed during setting.[30] This expansion increases as the freezing range becomes greater, this result having been confirmed for a number of copper alloys, especially those with zinc. Determinations of density show that the alloys have really contracted during freezing, and that the apparent increase of volume is represented by a considerable porosity, distributed throughout the cast bar. A part of this may be accounted for by the liberation of dissolved gases during freezing, but that this is not essential is shown by the example of the setting of plaster, mentioned above. The growth of a mass of crystals, if of dendritic form, may, and often does, lead to an outward push, the crystals seeming to repel one another as the liquid between them freezes. The result is that an outer shell is formed, and the contraction of the liquid metal contained in it, as it freezes in its turn, leaves small cavities, which may be so distributed that the casting appears solid unless examined under the microscope.

Table II.—*Volume Changes on Freezing.*

Metal or alloy.	Percentage change of volume on freezing. (− indicates contraction, + expansion.)	Author.
Tin	− 2.97	Goodrich.
Lead	− 3.85	,,
Bismuth	+ 3.47	,,
Zinc	− 4.48	,,
95 per cent. Sn + 5 per cent. Sb	− 2.81	,,
85 per cent. Sn + 15 per cent. Sb	− 1.91	,,
50 per cent. Sn + 50 per cent. Pb	− 2.30	,,
87 per cent. Pb + 13 per cent. Sb	− 2.15	,,
Aluminium	− 6.7	Stott.
87.4 per cent. Al + 12.6 per cent. Si	− 3.5	,,
Y-alloy	− 4.8	,,
Iron	− 2.86	(Mean of several.)
Iron	− 2.4	Ericson.
Grey cast iron	+ 1.2	,,
White cast iron	− 3.6	Honda and Endo.
Copper	− 4.0	Bornemann and Sauerwald.

The addition of zinc to tin-base bearing metals was found to cause internal porosity, and this was attributed[31] to expansion of the zinc during solidification, followed by contraction of the eutectic enclosed in it. Zinc does not expand, and the effect is due to thrust. Type-metals which behave in this way give sharp impressions of the mould, and it was long believed that they, like bismuth and some of its alloys, actually expanded, but determinations of the density prove that this is not so. Antimony, when present to the extent of 10 per cent., reduces the contraction to a very small amount. As the effect appears in the outermost shell of crystals, it is chiefly found in the narrow portions of a casting, and becomes negligible where the section is large. For the purposes of the foundrymen this apparent expansion is the same as a true expansion in castings of small section, but it has the effect of making the shrinkage allowance depend on the size. True expansion during solidification, as mentioned above, is exceptional in alloys. Quantitative measurements of crystal thrust have only been made with non-metallic substances, and from the nature of the cast the property could not be expressed by a simple constant.

Latent Heat and Thermal Conductivity

There are, of course, other physical factors which enter into the process of flow and solidification. Such are the latent heat and the thermal conductivity. More accurate values of the latent heat of fusion (or solidification) of metals are needed, only a few of the pure metals having been satisfactorily studied. Measurements of this property are in progress at the National Physical Laboratory, as are determinations of the thermal conductivity of metals and alloys in the solid state. In the liquid state this property is of less importance, as convection, or turbulent flow, brings about a quicker exchange of heat than conduction can do, but in steady or streamline flow it will have an effect, and for this reason some accurate determinations are desirable. The property would in all likelihood vary in a simple fashion over a range of alloys, so that it would only be necessary to make a few selected determinations.

Segregation

Nothing has been said as to the effects of segregation, but a short section may be added in the final form of the lecture for the Proceedings. It is naturally one of the factors which determine the quality of the resulting casting, but it is of a rather different character from the purely physical properties considered above. Mention should, however, be made of a possible effect of the degree of superheating to which the metal has been subjected before pouring. When heating has been carried far, and the metal is allowed to cool before casting, certain properties appear to depend on the maximum temperature which has been reached, the previous history of the liquid leaving an impress on its properties. This is particularly true of the grain size. It is often found that a larger grain size is obtained when the maximum temperature reached has been high than when it has been low, although the actual degree of superheat at the moment of pouring is the same. This may be explained in more than one way. It depends sometimes on the more complete elimination of suspended films, as of aluminium oxide, which hinder the growth of large grains, but it is not certain that this is the only cause. There is good reason to suppose that the regular arrangement of the atoms in a crystal is not completely broken down when the metal melts, but that aggregates of atoms, like extremely minute crystals, remain. On cooling, these form the nuclei from which crystals may grow. With increasing temperature, these aggregates tend to break up, so that a strongly superheated liquid would contain less nuclei, and would consequently give larger grains. There are indications, especially in the case of bismuth, which has received most attention, that this actually occurs. It is an important question, which calls for further study.

A better knowledge of the physical factors which affect casting properties is of the greatest importance, and an attempt has been made in this lecture to indicate which of them deserve attention, and which may be neglected for practical purposes. The writer acknowledges freely, however, that the acquired skill of the practical founder is something which, whilst not subject to quantitative expression, stands high in the rank of the factors controlling the quality of the casting, and it would not be right to conclude without a tribute to the value of such an Institute as this, in which the men who have such knowledge and skill can meet to compare their experience, and so to add to the progress of this ancient craft, now based on a scientific study of metals.

The Problem of the Elimination of Gaseous Impurities from Aluminium*

By GEORGES CHAUDRON (Professor in the Faculty of Sciences, Director of the Institute of Applied Chemistry of Lille)

[FRENCH EXCHANGE PAPER.]

It is, indeed, a great personal honour to have been chosen to submit to the Conference an Exchange Paper, but at the same time it is a very heavy responsibility, because the author has devoted the whole of his activities up to the present to problems of chemistry, and he would be greatly at a loss if he had to deal with a question of direct interest to foundry practice. He has assumed that the Institute would be interested in some observations of a chemical or physico-chemical nature which the author has recently made, and which might have some more or less remote application to the very complicated practice associated with the foundry industry.

In the course of the last two years, there has been perfected in the author's laboratory a new method for the degasification of metals, by means of which it is possible in particular to effect the complete determination of the gases of aluminium.[1,2] It was therefore considered that it would be possible to attack with new and more powerful means an important problem, which is that of the gases in aluminium. This problem may be divided into two parts:—

(1) To ascertain the value of the usual methods for the degasification of aluminium; and

(2) To provide the conditions enabling this metal to be remelted without recharging it with gases.

Actually, the foundry industry can procure aluminium of a very high degree of purity, but it must be pointed out at once that neither the hydrides, the carbonyls, nor even the nitrides are determined. In many foundry operations, however, gases may give rise to blow-holes which render the castings useless. It is a well-known fact that these gases are chiefly liberated at the moment of solidification, and it has rightly been said that in many cases it may be quite deceptive to have a purity corresponding to 99.99 if the last hundredth part consisted of gases.

The New Discharge Method of Degasification

Before describing this new method of degassing metals, it is desirable to recapitulate some experiments on the extraction of gases *in vacuo*. It has been clearly proved by numerous authors[3] that extraction in the solid or liquid state, even in very high vacua, has always been an extremely lengthy and incomplete operation.

A. Villachon[4] has studied this question with aluminium, and has shown that it is possible to remove the maximum amount of gas by heating in the solid state, but that, even after experiments lasting several months, extraction is still very incomplete. A discussion on the causes of this failure would seem profitable. The extreme slowness of the removal of the gases has been explained by attributing it to the low rate of diffusion of the gases in the interior of the sample, especially when the metal cannot be raised to a very high temperature. There is, however, an observation which contradicts this hypothesis and which indicates that the diffusion is appreciable even at the ordinary temperature. For instance, a sample of aluminium may be heated in a very high vacuum at a temperature of 550 deg. C., the gases being removed as fast as they are liberated. This experiment can be continued until a point is reached where no further appreciable removal of gases is observed. It is then found that each time the sample is left for some hours at the ordinary temperature, the extraction being arrested, a fresh liberation of gas is observed on subsequently reheating the sample. This experiment may be repeated a very large number of times, which obviously proves the existence of an appreciable diffusion at the ordinary temperature.

PROF. G. CHAUDRON.

It was therefore thought that the liberation of gases was particularly difficult when the gases were leaving the boundary of the metallic lattice, and that, in short, a mass of metal could be imagined as being surrounded by a skin which is not very permeable to gases. Physicists explain that at the boundary of the metallic lattice there exists a potential barrier which would play the part of this skin exactly.

BIBLIOGRAPHY.

1 L. Moreau, G. Chaudron, A. Portevin: "Sur une Nouvelle Méthode d'Extraction des Gaz dans les Métaux" (On a New Method of Extracting Gases from Metals), "Comptes Rendus," 201, 212, 1935.

2 A. Portevin, G. Chaudron, L. Moreau: Nouvelle méthode pour Extraire les Gaz des Métaux et Contributions à l'Etude des Gaz Retenus dans l'Aluminium" (New Method of Extracting Gases from Metals and Contribution to the Study of the Gases Retained in Aluminium). Anniversary Volume of the Science Reports of the Imperial University Tohoku Sendai, Japan, 1936.

3 Smithells: "Les Impuretés dans les Metaux" (Impurities in Metals), French translation Dunod, 1930. Sieverts, Z. Metallkunde, 37, 21, 1929.

4 Villachon: Thesis, Lille, 1932.

5 A. Portevin, G. Chaudron and L. Moreau: "Contribution à l'Etude des Gaz dans les Métaux" (Contribution to the Study of the Gases in Metals). "Comptes Rendus," 204, 1252, 1937.

6 G. Chaudron: "Le problème des gaz dans les Métaux" (The Problem of the Gases in Metals). Paper read at the XVth Conference of Industrial Chemistry, Brussels, 1935, published in the reports of the Conference.

7 L. Moreau: "Essai à la Cloche des gaz de l'Aluminium" (Bell-jar Test of the Gases of Aluminium). Bulletin de l'Association Technique de Fonderie, December, 1936, p. 446.

8 J. Herenguel: Thesis, Lille, 1935.

The author has advanced the hypothesis that if this potential barrier could be disturbed, it would be possible to extract rapidly the gases enclosed in the metal, and to do this he has employed the bombardment in a discharge tube where the projectiles were ions and electrons. The sample to be degassed is made the cathode in a discharge tube. For many reasons, which it would not be of interest to enlarge upon here, a bulb of rather large diameter and of very definite dimensions was selected (Fig. 1). This bulb is connected to a mercury vapour pump which delivers into a cascade of mercury enabling the gases removed to be collected. The electric discharge passes at a very low intensity —a few milliampères—and at a tension which may be as high as 130,000 volts. It is important to note that under these conditions the bombardment of the sample does not produce any appreciable rise in temperature. This cold extraction is of the greatest interest because it is thus possible to investigate the part played by the gases in the metal; for example, their influence on the electrical conductivity, the mechanical properties and the dimensions of the lattice, but that has been studied by others,[8] and it would be digressing to discuss it further.

TABLE I.—*Comparison of Gas Extraction Results obtained by Various Processes.*

Method of extraction.	Volume liberated per 100 grams. Ml.
Heating at 600 deg. C. for 1 month in a vacuum higher than $\frac{1}{100}$ mm. of mercury	12.5
Fusion and extraction in a vacuum higher than $\frac{1}{100}$ mm. of mercury ..	20
Discharge tube	192

It is necessary to point out that in order to effect the degasification, it is by no means necessary to bombard the whole of the surface of the sample. On the contrary, it is possible, for instance, to extract all the gases from a long aluminium wire by introducing a very short length into the tube, or, again, it is possible to effect the degasification of a long aluminium strip by coiling it and then placing it in the discharge tube. These experiments show clearly that diffusion may take place in the cold. Finally, this method enables much greater quantities of gases to be extracted from aluminium than the amounts obtained by previous investigators in this field.

TABLE II.—*Gas Extraction results from Diverse Processes.*

	The nitrogen is calculated in ml. per 100 grams of metal.		
	A.*	B.	C.
Aluminium, 99.99 per cent. pure	7.2	3.1	10
Commercial aluminium, 99.7 per cent. pure ..	12.5	2.8	13
Calcium (99 per cent. pure, sublimed)	45	55	118

* A denotes the nitrogen extracted by new method. B the nitrogen determined chemically after extraction, this being therefore the residual nitrogen, because in these experiments which were carried out at the commencement of the investigations, degasification was not carried to completion. C denotes the nitrogen determined chemically on the initial metal.

Comparison of the Volumes of Gas Extracted by Heating *in vacuo*, by Fusion *in vacuo* and by the New Method

Table I summarises the author's results on the same sample.[6]

The nitrogen which is combined with the aluminium in the form of nitrides may be estimated by the following well-known method:—The metal is dissolved in caustic soda, the solution is boiled

* Paper presented to the Annual Conference of the Institute of British Foundrymen held at Derby from June 8 to 11.

and the ammoniacal vapour is collected in a titrated liquid. It was of interest to ascertain whether the new method of extraction gave the same results as the chemical method. It will be seen from Table II, which summarises some experiments, that the relationship A + B = C is substantially confirmed.

The results given in Table I confirm that heating *in vacuo*, either in the liquid or solid state, does not allow of a complete degasification of aluminium, in fact, it may be said that this is far from being the case.

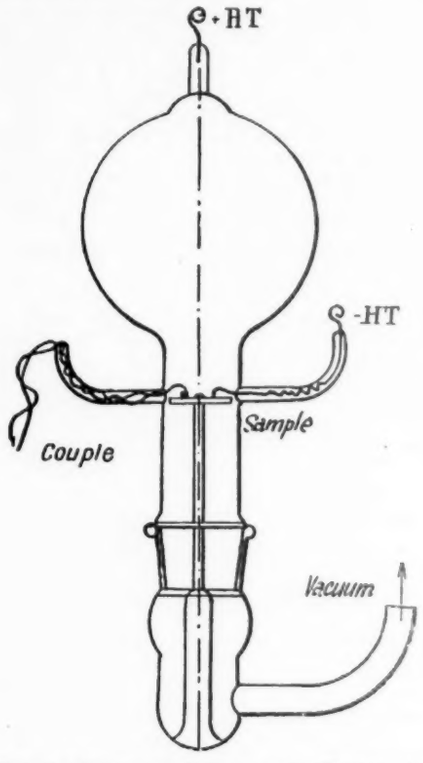


FIG. 1.—DISCHARGE TUBE FOR THE EXTRACTION OF GASES.

It is found in fact that these partly degasified metals no longer exhibit any blow-holes after solidification, even if the latter is effected *in vacuo* ("Rochage"[*] *in vacuo*). This test is, in fact, extremely sensitive, solidification takes place in a vacuum of the order of one millimetre of mercury, and therefore under these conditions any bubbles which would tend to form would occupy a volume several hundred times greater than at atmospheric pressure—theoretically almost 760 times greater (Figs. 2 and 3).

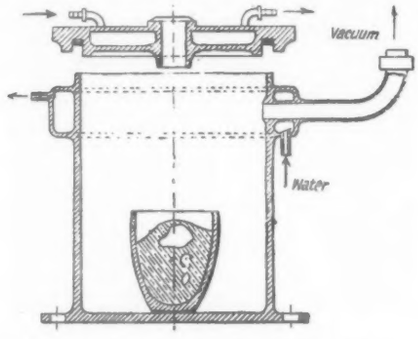


FIG. 2.—VESSEL FOR CARRYING OUT THE "ROCHAGE" TEST *in Vacuo*.

TABLE IV.—*Influence on "Rochage" of Bubbling Various Gases through Liquid Aluminium.*

No. of test.	Metal investigated, electric furnace method.	"Rochage," *in vacuo*.	Gas extracted by discharge degasification. Ml. per 100 grams metal.					Nitrogen evolved by chemical method. Ml.
			Total gas.	CO_2.	Co.	H_2.	N_2.	
1	Original metal, Al 99.7 per cent.	Very slight gas evolved	137	2.8	30.2	98.0	6.0	*6.4*
2	The same, treated with flux	No gas evolved	124	3.2	27.0	90.5	3.4	2.8
3	Bubbling H_2 at 950 deg. C.	Gas evolved ..	167	3.0	33.0	*127.0*	3.9	3.2
4	Bubbling CO at 90 deg. C.	Gas evolved ..	167	3.0	33.0	*127.0*	3.9	3.2
5	Bubbling CO_2 at 950 deg. C.	No gas evolved	127	3.0	32.0	88.0	4.2	3.9
6	Bubbling dry N_2 at 950 deg. C.	No gas evolved	127	3.0	32.0	88.0	4.2	3.2
7	Bubbling moist N_2 at 950 deg. C.	No gas evolved	127	3.0	32.0	88.0	4.2	3.4
8	Bubbling N_2 at 1,200 deg. C.	Gas evolved ..	127	3.0	32.0	88.0	4.2	*18.6*
9	Bubbling NH_3 at 900 deg. C.	Gas evolved ..	127	3.0	32.0	88.0	4.2	*40.0*
10	Aluminium nitrided with NH_3	Gas evolved ..	128	3.0	29.0	80.0	15.4	*17.6*

nitrogen is occluded in the metal and is not combined with the aluminium. Finally, these nitrogen determinations show that the content of 5 ml. per 100 grams appears to be a limit of solubility. Above this content, it would seem that the nitrides are free in the liquid metal, because they can be removed from the aluminium by filtration. The same observation has been made in the case of magnesium.[8]

It certainly seems that the nitrogen content may suffice to indicate whether a metal is unsafe to employ in the foundry, and, as will be shown later, will clearly demonstrate that the other gases in excess may act in the same way. Above certain contents, which are comparatively high, of carbon monoxide and hydrogen, the metal may likewise spit.

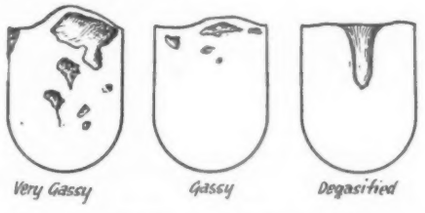


FIG. 3.—SECTION OF ALUMINIUM INGOTS AFTER THE "ROCHAGE" TEST *in Vacuo*.

Comparison of Industrial Methods of Degasification

It is now proposed to consider the simple methods which have very often given practical results, namely, those in which an inert gas is bubbled through the liquid metal, and the methods in which the liquid metal is stirred with fluxes. Table III summarises the results obtained.

None of these methods produces a metal freed from its gases, but there is obviously an appreciable reduction in the contents, the nitrogen figure having decreased by about 50 per cent. Practice has shown, however, that metals thus treated and therefore only partly degasified have given every satisfaction.

TABLE III.—*Gas Evolutions under Diverse Conditions.*

No. of test.	Metal tested.	"Rochage," *in vacuo*.	Degasification by discharge. Nature of gases—ml. per 100 grams of metal					Nitrogen by chemical method. Ml.
			Total gas.	CO_2.	CO.	H_2.	N_2.	
1	Original metal, Al 99.5 per cent.	Gas evolved ..	231	14.5	42.25	152	17.75	11.8
2	Metal stirred with a flux ..	No gas evolved	175	4.9	35.0	128.9	6.0	4.9
3	Metal chlorinated by bubbling chlorine through ..	No gas evolved	175	5.6	38.0	123.35	8.05	5.6
1	Original metal, Al 99.7 per cent.	Gas evolved ..	205	5.0	53.7	130.3	16.0	12.0
2	Metal stirred with a flux ..	No gas evolved	165	4.1	33.9	119.6	7.4	6.5
3	Metal chlorinated by bubbling chlorine through ..	No gas evolved	173	4.8	45.3	115.0	7.5	5.2

For the practical details of this test, ("Rochage" *in vacuo*), reference should be made to an article by the author's collaborator Moreau.[7] Reverting to the nitrogen determinations indicated in Table III, it should be noted that, in the first place, there is a fairly good agreement between the results found by the discharge method and the results found by the chemical method. It should be noted, however, that the nitrogen estimated chemically is always smaller in quantity than the total nitrogen as determined by the discharge method, whence it may be concluded that very probably some of the

[*] "Rochage" is the quantity of gas liberated on solidification. It is sometimes accompanied by spitting, as in the case of oxidised silver.—EDITOR.

Influence of the Composition of the Gaseous Atmosphere and the Melting Temperature on the Gas Content and on the "Rochage" of the Metal

In these experiments, two factors were varied in succession:—

(1) The metal was melted in an electric furnace and, while the temperature was maintained constant, a given gas was introduced, and

(2) For a given gas bubbled through, the temperature was varied.

This programme of work has not yet been completed, but it is considered that there are sufficient facts already available to enable several conclusions to be drawn from them. Table IV summarises these experiments. It may be said that below 900 deg. C., employing temperatures between 800 and 850 deg. C., it has not been possible appreciably to charge the metal with gas, but above 900 deg. C. the mere fusion in a blower-operated gas furnace of a sample of aluminium which originally did not exhibit any "Rochage" is sufficient to render it gassy. It has, on the contrary, been possible to effect several successive fusions in the electric furnace without observing any charging with gas provided 950 deg. C. was not exceeded. These experiments are summarised in Table V.

These experiments clearly show the advantage of heating in the electric furnace. An electric furnace was used having a nichrome resistance,

(*Concluded on page* 516.)

Recommendations Concerning the Establishment of Costs in a Grey Iron Foundry

By the Costing Sub-Committee of the Technical Committee of the Institute of British Foundrymen

(*Concluded from page* 466.)

COSTS IN THE MOULDING DEPARTMENT

Direct Costs

Direct costs are those which can be charged specifically to a job. In order to conform with the first fundamental principle—namely, that "an expense incurred for a job should be charged to that job"—one should aim at bringing in as much as possible under the heading of "direct costs." Items which must be considered under this heading are:—Labour, moulding boxes, patterns and tackle when specially made for a job, and certain consumable materials wherever it is possible that such materials can be charged direct to the job. In order to apply the principle that wherever possible costs should be applied direct to their specific job, each job should be timed so that the correct amount of direct labour costs can be charged to the job.

Furthermore, in order to be able to apply the correct share of overhead costs to each job, castings should be classified in the moulding department in accordance with the method of preparing the mould; therefore, a distinction should be made between machine-made moulds, hand-made moulds, loam moulding, dry-sand moulds, green-sand moulds, and there should be corresponding divisions in direct labour costs when making up the periodical cost sheets. In certain cases the moulding machine section should be sub-divided into sub-sections in accordance with the type of machine used.

Moulding Boxes.—In accordance with one of the fundamental principles of the system, whenever moulding boxes are made for a specific job, their actual cost, less scrap value, must be considered as a direct charge against that particular job. Any other boxes, purchased or made in the foundry and used for general purposes—that is to say, those that are not used for a specific job—should be debited at cost to a "box part account." This account should be liberally depreciated and the depreciation charged to the moulding department as a departmental overhead. This account should be credited with the scrap value of discarded boxes at the time they are scrapped.

Foundry Tackle.—This is treated in the same way. When made for a specific job, it is charged to the job; when made for general purposes, it is debited to a special account and liberally depreciated.

Patterns.—The same principles apply to patterns as those established for moulding boxes; patterns made for a specific job should be charged against the job. The method of establishing pattern costs is explained in a special section dealing with the pattern shop considered as an auxiliary department.

Materials.—Such materials as chaplets, sprigs, wires, etc., should, whenever possible, constitute a direct cost against the job. When this can be done, such materials should be the subject of a stores issue, against an identification such as an order number, which ensures their direct charge to the specific job. In other cases the charge is to be entered against the foundry.

Indirect Costs

Indirect costs cover costs which, by their very nature, cannot be ascribed directly to any particular job. Indirect costs comprise:—Indirect labour; moulding sand; miscellaneous supplies and tools; repairs, etc., and a share of general overhead expenses. As many separate accounts as possible should be kept, in order to enable costs to be properly analysed. A list of some such items is given at the end of this section.

Indirect Labour.—This account covers the wages of all labour employed in the moulding department that cannot be accounted for under the heading of "direct labour"; it includes the wages of men occupied in the sand mixing and reclaiming plant, the wages of men in charge of mould-drying stoves, the wages of men in charge of repairs. The wages of men whose duties are divided between the moulding and another department should be divided in proportion to the time spent in each department.

Moulding Sand.—New moulding sand is included in this account. Labour employed in the sand preparation plant for reclaiming used sand, and depreciation and maintenance of sand plant, are to be charged against the moulding department in the "departmental overhead" account. In some cases, the sand preparation plant can be considered as an auxiliary department, the total cost of which is charged as a departmental overhead of the "moulding department"; this procedure enables a better control of the cost and efficiency of the sand-preparing plant to be effected.

Miscellaneous Supplies and Tools.—In general, the cost of plumbago, blackings, etc., and loose tools should be spread over the moulding department. In foundries that are divided into separate sections, these costs should be allocated between the various sections, bearing in mind the general principle that "a charge incurred for a job should be a direct charge against the job": for instance, spare parts or tools used specifically in conjunction with moulding machines should be charged to the machine moulding section. Special tools used for loam moulding should be charged against that section.

In accordance with the same fundamental principle, fuel used in the mould-drying stoves should be a charge against the dry sand moulding section, as well as the maintenance and depreciation of the stoves. Again, as far as possible, chaplets, sprigs, wires, etc., should be charged against the job for which they are used. As previously stated, whenever materials can be charged direct to a job this should be done. The safest way to ensure that all such supplies are accounted for is to charge them against the moulding department at the time they are issued from stock, and a proper system of stores issuing and accounting, with direct charging wherever possible, should be instituted.

Repairs.—Unless men are fully employed in doing repair jobs, labour costs for repairs are included under the general heading of "indirect labour." All materials and spare parts used in the repair of moulding equipment and of ladles are to be charged as a departmental overhead against the moulding department, or its various sections, *pro rata*. In the larger undertakings, repairs and maintenance of plant and equipment may constitute a separate auxiliary department: in such cases the costs of this auxiliary department are classified and allocated to the four main departments and their respective sub-sections as departmental overheads.

Foremen, Clerks, etc.—In those undertakings where a number of foremen and clerks are fully employed in the moulding department, their salaries constitute a departmental overhead.

Heat, Light and Power.—These items of expenditure can be measured or closely estimated in proportion to their utilisation by the various sections of the moulding department. Heat and light can be allocated on a floor basis; power can be allocated on the basis of consumption of the various plants utilising power. This is a departmental overhead. In those undertakings which operate their own power plant, these items constitute an auxiliary department, in which the cost per unit of the medium of power can be determined. This cost is then allocated on the basis established in the preceding paragraph.

Fixed Charges.—These include rent, rates, taxes, depreciation of buildings and plant, insurance, etc. For depreciation and insurance of buildings, a departmental factor can be worked out on a floor basis. Depreciation of plant and equipment should be computed on the basis of value and probable life of each kind and type of plant. Rent, rates and taxes are worked out on a floor area basis.

An allocation should be made at the beginning of each year for each department or section of the undertaking. All items of general expense that can be definitely allocated to the moulding department should be so charged. Such items of general expense that cannot be divided between the various departments of the undertaking, such as administration expenses, social charges, selling costs, outward freight, financial charges, bad debts, etc., are dealt with at a later stage.

Method of Allocating Overheads in the Moulding Department

The various methods of allocation, on the basis of direct wages, time, space and tonnage, were considered and compared at length at several meetings of the Sub-Committee and discussed by correspondence. It has been found that the simplest and soundest method applying to the average-size foundry is that based on direct labour. This method is open to some criticism in certain cases, but so are all the other methods. The Sub-Committee has ruled out the tonnage basis as definitely unsound; the space and space-time methods have been found too complicated and open to objections.

In certain cases the time method would be acceptable, but it has been found that for the majority of cases, and in view of the fact that in any case wages must be accurately recorded, the "direct labour" method is the best to adopt for a uniform system, and the one least likely to offer the risk of inaccuracies and complications. The Sub-Committee therefore recommends that overhead charges in the moulding department be computed on the basis of "direct labour."

Where a fair number of apprentices are employed, it is recommended that the percentage of overheads applied to apprentice wages should be increased in relation to the difference between ordinary moulders' wages and apprentices' wages, taking into account the relative numbers of men employed in each category. A formula*

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* The formula is as follows, x being the percentage applying to the experienced moulder's wage, and y the percentage applying to the apprentice's wage:—

$$x \text{ per cent.} = 100 \frac{O}{M + pA}$$

$$y \text{ per cent.} = px \text{ per cent.}$$

Where O is the amount of overheads to be allocated during a given period.

M is the total amount of wages paid to the experienced moulder during the period.

A is the total amount of wages paid to the apprentice during the period.

p is the amount by which the unit wage of the apprentice is smaller than the unit wage of the experienced moulder—*i.e.*, if apprentice wage is $\frac{1}{2}$ the moulder's wage, or twice as small, $p = 2$; if $\frac{1}{3}$, or three times as small, $p = 3$.

is available which gives the correct percentage applying to each category, but if the result be obtained by approximation, care should be taken and a check made to ensure that the full amount of overheads has been accounted for.

The Sub-Committee cannot offer recommendations applying to widely exceptional cases, except that the fundamental principles of this system should be applied, but that their detailed application should be adapted to the circumstances of the case and governed by common sense.

NOTE.—Knocking-out costs must not be overlooked; their treatment depends upon the organisation of the foundry. In most cases the knocking-out station is in the moulding department; in other cases in the fettling department. It may be treated as a direct or an indirect cost. In any given case, the principles of the system must be applied to that particular case.

Application of the System

The following is a list of certain current items of cost that make up the overhead expenses relating to the moulding department. This list is not exhaustive and should be modified in accordance with the circumstances of each undertaking; it is given merely as a guide. Certain headings, such as box parts, foundry tackle, materials *ex* stores, are included to cover those items that could not be charged as "direct costs" against a particular job.

Labour, unproductive: Wages.
,, ,, : Salaries.
,, ,, : Stores.
,, ,, : Packers.
Box parts: Labour.
,, ,, : Materials.
Foundry tackle: Labour.
,, ,, : Materials.
Sand: Labour.
,, : Materials.
(or cost of sand preparation auxiliary department.)
Drying stoves, labour and materials.
Materials *ex* stores.
Coal dust.
Moulding machines, repairs, labour and materials.
Plant repairs, labour and materials.
Salaries.
Coal and gas.
Power, light and heat.
Handling of materials, castings, etc.
Workmen's compensation insurance.
National Health Insurance.
Unemployment Insurance.
Laboratory wages and salaries.
,, materials.
Rent and rates.
Depreciation of boxes.
,, ,, fixed and movable plant, etc.

Those items that can be allocated to a particular section of the foundry should be extracted from this list and allocated to the proper section; for instance, the cost relative to drying stoves, including fuel, should be charged to the dry-sand mould section; repair and depreciation of moulding machines should be charged to the machine-moulding section; tools used for loam moulding should be charged to the loam moulding section, etc.

All the other items that apply to all sections of the foundry are then totalled; the ratio of the total amount relating to these items to direct labour costs in the moulding department is taken. In each section of the foundry, the ratio of overheads specifically charged to that section to direct labour costs in that section is also taken.

For instance, if total direct wages in the moulding department during a costing period amount to £200, and all items of indirect cost applying to all sections of the foundry total £160, the percentage to apply to direct labour costs to cover these items is 80 per cent., or for each 20s. of direct labour 16s. should be added. If direct wages in the dry-mould section amount to £120 and the overhead applying specifically to that section amounts to £30, 25 per cent. of direct labour costs should be added further for that section, or 5s. for every £1. In the same way, the moulding machine overhead might be 15 per cent. of direct labour costs for that section.

Applying this to a job made from mixture A, yielding 67½ per cent. of good castings, made with dry-sand moulds on a moulding machine, the overhead applying to all sections of the foundry will be 80 per cent. of direct wages charged to the job, plus 15 per cent. for the moulding machines, plus 25 per cent. for the drying stoves; therefore, the percentage overhead for this job will be 120 per cent. of direct wages. This gives:—

	£	s.	d.	
Cost of metal at the spout, per ton of good castings (obtained from melting department, Mixture "A," Class 11)	4	4	0	
Direct Labour	2	15	0	(L)
Overhead—120 per cent. of L	3	6	0	
Patterns, cores, boxes, etc.	0	15	0	
TOTAL COST	£11	0	0	

This gives the cost per ton of good castings of the job up to the point where it leaves the moulding shop.

THE CORE DEPARTMENT

The core department is just as much a productive department as the moulding department—therefore, core costs must not be considered as an overhead charge against the moulding department, but must be calculated in the same way as moulding costs. Furthermore, cores must be identified with the job for which they are made and their cost charged accordingly to the respective jobs.

Wages must be carefully recorded, a separate record being kept of direct wages paid to the coremakers, as this will be the basis for the allocation of overheads. For this purpose also, core jobs should be classified on the cost sheets, as between green-sand cores and dried-sand cores, hand-made and machine-made cores.

As far as is possible, efforts should be made to treat the cost of the sand, core oils, binders, etc., constituting the core mixture in a direct manner. The cost per cwt. of any particular core mixture can be ascertained quite simply. The weight of mixture required for any particular core is also easily ascertained. In this way the cost of a mixture for particular cores can be arrived at.

Like moulding boxes, core boxes and jigs made specially for one job should be charged to that job. Other equipment for running production should be debited to a special account and liberally depreciated, this depreciation being charged as a departmental overhead against the core department. Core-irons, wires, grids, etc., should not be overlooked. In large engineering jobs they may rise to a considerable amount. In any case, they should be properly issued from stores and properly accounted for.

Departmental overheads include, in addition to the items already mentioned in the section relating to the moulding department, maintenance and depreciation on such items as the core-drying ovens, core machines, etc. Core wastage in general should be charged in the core shop, and the resulting cost of good cores is charged to their respective jobs in the foundry. As in the moulding department, the overheads of the core shop should be allocated to the various jobs on the "direct labour" basis.

The Pattern Shop

This is considered as an auxiliary department. In accordance with the fundamental principle of the system, patterns made for a specific job should be charged to that job; if made for a special client, the cost should be charged to the client. As in other departments, the expense of the pattern shop includes:—(*a*) Direct costs—*i.e.*, direct wages and material; (*b*) indirect costs—*i.e.*, indirect materials, such as screws, varnish, paint, and (*c*) overhead expense which cannot be charged direct.

As regards direct costs, these are charged direct to the patterns made for special jobs, and to running patterns respectively. Any indirect costs that can reasonably be charged to specific jobs should be so charged. All other overheads are calculated as a percentage of "direct labour," so that specific jobs should bear their proper share of such overheads. Then all new running patterns are capitalised, and their depreciation, together with maintenance, repairs, and overheads not already charged to specific jobs are charged as an oncost of the moulding department.

THE CLEANING AND FETTLING DEPARTMENT

This department covers all operations effected on castings from the time when they are knocked out of the mould until they are cleaned and dressed. Any other special treatment of the surface of a casting—as, for instance, enamelling or other finishing operations—is not included in the cleaning and dressing department and is outside the scope of the present system.

It is recommended that the cleaning and fettling department should be divided into two main sections:—(*a*) A section where labour is the main item of cost and where one casting is dealt with at a time, such as is the case for chipping, grinding, filing, wire-brushing, etc.; (*b*) a section covering operations in respect of which the principal item of cost is power and depreciation of plant, and where a number of castings are treated together, such as is the case for tumbling, sandblasting, pickling.

With regard to section (*a*), labour is a direct cost applying to each job, and all departmental overheads, including the cost of files, chisels, brushes, hammers, emery wheels, etc., are to be allocated on a direct wage percentage basis. In quite a number of foundries where plant is not used, this system will apply quite simply.

As regards section (*b*), a simple system consists of adding up all costs, including power, labour, depreciation of plant, abrasives, shot, and departmental overheads less any portion charged to section (*a*), and allocating the total cost to each job on a weight basis.

For the larger foundries where various types of plant are used, such as tumbling barrels and sandblasting plant, a more precise system is recommended. It will be realised that weight is not the only factor that intervenes in these types of plant; the time necessary to clean various kinds of castings is another variable factor, which depends more upon the shape and degree of intricacy of the casting than upon its weight.

In tumbling barrels, all the castings are put in and taken out at the same time, and if there is only one barrel, its cost cannot be allocated otherwise than on a weight basis, but if a foundry uses more than one tumbler, it should be possible, as a result of experience, to allocate the barrels to classes of castings, putting together those castings that take the same time to clean. The direct cost of operation of each barrel can be arrived at, and for each one that cost is charged to the castings on a weight basis; the overheads of the tumbling section should be added, also on a weight basis.

In sandblasting, in those cases where the castings can be taken out when they are cleaned without disturbing the other castings for which the operation is not completed, the castings can be classified or tabulated in accordance with the time taken to sandblast them. Experience will tell to which class a particular casting should belong. Taking into account the total tonnage

passed during a given period, the cost of operating the sandblasting section, including overheads, can then be charged to the castings on a ton-hour basis.

Castings Inspection Charges.—When special inspection is effected for a specific job, the cost should be charged to the job. In other cases inspection costs should be charged as an oncost on the departments concerned.

Other Auxiliary Departments.—In undertakings that operate their own light, heat and power plant, this should be considered as an auxiliary department, and the cost per unit should be worked out, taking into account all overheads applying to that department. The cost of heat, light and power thus being known, it can be applied to the various departments of the undertaking, as explained in the costing system.

If there is a separate maintenance and repairs department, whenever possible individual costs should be worked out and charged to the appropriate place. For general maintenance and repair work, the cost is an overhead on the appropriate department.

Packing and Despatching.—These items should be regarded as an overhead, and calculated as a percentage of productive labour in the moulding department.

Freight.—This is an item the cost of which is usually determined for particular jobs, and it can be added at the end of the cost sheet.

GENERAL OVERHEADS

There are a number of items, additional to actual production costs, such as directors' fees, workmen's mess rooms and clubs, financial charges, etc., which cannot easily be allocated to any particular department. There is also the question of selling costs and publicity.

At the stage now reached it can be stated that all actual manufacturing costs have been considered, and if such costs are calculated by means of a system that is uniform for the industry, there is available a basis upon which such manufacturing costs can properly and fairly be ascertained and recorded. The point is, therefore, reached where the main object of the Sub-Committee has been fulfilled, provided that the principles that they have endeavoured to establish prove acceptable.

As for the items of expenditure referred to in this paragraph as "general overheads," it is suggested that they should be considered apart from, or in addition to, the actual manufacturing costs. The items now under review vary considerably from one undertaking to another. There are cases where directors are in charge of a department and receive a fixed salary, which then becomes a departmental oncost. Some undertakings may be in the fortunate position of having no financial charges. Some are not of sufficient size to finance and maintain workmen's clubs, etc. Publicity and selling costs vary widely. These items, by their very nature, may tend to distort the truly comparable value of actual manufacturing costs arrived at so far.

It is, therefore, suggested that the basic production cost figure is that arrived at at the despatch stage, and before freight is added. Then, to complete the costing process of any given undertaking, the general overheads must be added to the manufacturing cost figure, and allocated as a percentage of productive labour on direct moulding and core shop wages.

The recommendations set out in this report are postulated in the hope that, subject to any adjustments and additions that may arise from the discussion, they will be accepted as guiding principles by the industry at large, which will then be provided with a proved and comparable costing system.

Finally, the Costing Sub-Committee is prepared to remain constituted in an advisory capacity in order to facilitate the application of the system, particularly as regards the smaller jobbing foundries, and to co-operate with such foundries in adapting the system to their particular case.

The Use of Nickel in Non-Ferrous Alloy Castings*

By J. O. HITCHCOCK, B.Sc.

Nickel is to-day being used in many different types of non-ferrous castings, and for the present symposium it was thought that it would be of interest to review its position in this field. This Paper, therefore, does not touch original ground, nor is it intended to be highly technical, or even inclusive, but its purpose is to show the scope of the application of nickel in relation to all the common non-ferrous casting alloys. The field is so wide that much detail has of necessity been omitted and attention has been directed primarily to those alloys considered to be of special interest from the foundry point of view at the present time, *viz.*, the bronzes and nickel-silvers.

Whilst the Paper is confined in most cases to describing the beneficial effects of nickel additions, it must not be concluded that all the foundryman has to do is to add some nickel to his casting, whatever the alloy, to improve it. There are cases where nickel or excess nickel can be deleterious, and, when nickel is used, extra foundry precautions may sometimes be necessary. Nickel additions, like those of other alloying elements, may well be wasted if not scientifically used.

Although the melting point of nickel is higher than the other common non-ferrous metals used in the foundry, it dissolves without undue difficulty in the majority of them, though pre-alloys or alloyed ingots are desirable for certain compositions. The facility with which nickel alloys with other elements has been one of the reasons why it has received so much attention in the past.

With few exceptions, the general influence of nickel is similar, whatever the base to which it be added, and it can be broadly stated that it has the following effects:—(1) Raises the melting point; (2) increases the strength and hardness; (3) assists in the retention of these properties at elevated temperatures; (4) decreases the grain size; and (5) improves the corrosion resistance. Apart from the consideration of the intentional addition of nickel to castings, the fact that appreciable percentages of nickel are frequently present in available scrap renders it doubly important to understand its influence.

MR. J. O. HITCHCOCK.

Bronze

The use of nickel in bronze dates back many years, and there have been many references to the matter in technical literature, but apart from broad statements of its beneficial effects, there has not, until comparatively recent years, been any fundamental study of the subject. Now, however, as the result of researches carried out, particularly in America,* the position is rather more clear. Special attention has recently been focussed on this subject, because of the present wide price difference between tin and nickel and the possibilities that exist for effecting substantial economies in metal cost by the replacement of a portion of the tin by nickel.

The α-phase area of tin bronzes is considerably narrowed by the addition of nickel, and consequently the hard constituent separates out at progressively lower tin contents as the nickel content is raised, thus enabling a minimum tin content to be used to give a desired hardness. There is, in addition, evidence of some not yet fully understood constituents present in nickel-containing bronzes. High nickel contents give rise to precipitation-hardenable alloys, since the solubility of the constituent that separates out falls with temperature. It has been stated that very roughly equivalence in gross structure follows the substitution of nickel for a like amount of tin and the desirable tin contents in bronzes containing nickel are less than in the nickel-free bronzes.

A further structural effect resulting from the presence of nickel relates to the distribution of lead in lead-containing bronzes. The fact that the addition of a small percentage of nickel promotes even and fine distribution of lead in bronzes of both low and high lead content has been recognised for many years, and this has been attributed to the fact that it increases the solubility of lead in molten copper. In addition, the solidification point is raised and the lead has less chance to segregate and is mechanically trapped. Zinc appears to counteract this effect of nickel, and nickel is not so effective in low tin content alloys. It has been suggested, therefore, that as lead appears to be carried with the hard tin constituent, the effect of nickel is through its influence on the distribution and the proportion of this constituent. In the presence of phosphorus, nickel, like copper, forms a phosphide compound.

The effect of nickel on the physical properties of bronzes is marked. It is generally accepted

* Paper presented to the Thirty-Fourth Annual Conference of the Institute of British Foundrymen held in Derby from June 8 to 11.

* For full particulars of these experiments see:—

1 N. B. Pilling and T. E. Kihlgren. "Some Effects of Nickel on Bronze Foundry Mixtures." Trans. Amer. Foundrymen's Assoc., 1931, vol. 2, pp. 93–110.

2 E. M. Wise and J. T. Eash. "Strength and Ageing Characteristics of the Nickel Bronzes." A.I.M.E. Tech. Pubn. No. 523, 1934.

3 N. B. Pilling and T. E. Kihlgren. "Casting Properties of Nickel Bronzes." Trans. Amer. Foundrymen's Assoc., 1932, vol. 3, pp. 289–305. N. B. Pilling and T. E. Kihlgren. "A Method for Study of Shrinkage and its Distribution in Castings." Trans. Amer. Foundrymen's Assoc., 1932, vol. 3, pp. 201–216.

that nickel densens bronzes, although exactly what is meant by this is not always clearly defined. It has been demonstrated, however, that whilst the true freezing-shinkage is not modified to any important extent by the addition of nickel, this element does enable sounder castings to be produced, particularly when the pouring temperature is high. Associated with this effect is the question of grain refinement. This again is a definition requiring further explanation, since, as Pilling and Kihlgren' [2] have pointed out, true grain size is probably only one of the several factors affecting the texture of a fracture as seen by the naked eye. The elimination of internal oxidation, the dispersal of incipient shrinkage cavities, the method of fracture, as well as changes in size or shape of the grain itself, all alter the nature of this appearance. Apart from its influence on density, however, nickel did appear (from Pilling and Kihlgren's experiments) to have an actual effect in reducing the true grain size. In the usual range of pouring temperatures, the refinement averaged about 50 per cent. reduction in mean grain size (diameter) for the addition of 1.5 per cent. of nickel or less. It has also been reported that the coarse dendritic grain growth caused by the presence of small quantities of aluminium or silicon in low-tin leaded-bronzes is counteracted by nickel, although 2 to 3 per cent. is necessary to offset the effect of 0.05 per cent. silicon.

Considerable investigation has been made of the way in which the mechanical properties of bronze are influenced by the presence of nickel. The magnitude of the effect depends on the nature of the base metal, and foundry practice, and differs also according to whether nickel is being used to replace copper or tin. Most of the data available relate to additions to a standard base-alloy but, as mentioned above, the present tendency is to consider the matter from the tin-replacement point of view. In general, it may be said that nickel improves the tensile and compressive strengths and hardness of bronzes, without detriment to, and frequently with improvement in, toughness and ductility. Increases in proportional limit and yield point relatively greater than the increase in maximum strength are achieved. The optimum nickel content varies with the base mixture, and is, in general, lower with higher tin and/or lead content. Increasing the nickel beyond this optimum content may result in a decrease in the elongation value and necessitate special foundry treatment. The most useful nickel range is usually between 1 and 2 per cent., but in certain instances as little as ½ to ¾ per cent. is distinctly beneficial. (Table I.)

Improvement by Heat-Treatment

Interesting results have been obtained on the improvement by heat-treatment of the mechanical properties of nickel-tin bronzes of rather higher nickel content than dealt with above. A prolonged soaking at a high temperature (in the region of 760 deg. C.), followed by a softening quench and subsequent low-temperature tempering treatment at approximately 260 to 300 deg. C., markedly increases the mechanical properties of certain compositions. As an alternative to this heat-treatment, the cooling of a sand casting can be so controlled as to develop the precipitation-hardening effect in the as-cast condition. Special care is necessary in melting these heat-treatable alloys, and impurities need to be carefully controlled to give optimum results. Typical compositions which show promise of considerable development falling in this group are the 88:5:5:2 copper-tin-nickel-zinc alloy, and the alloy containing 7.5 per cent. nickel and 8 per cent. tin. The latter, in the form of heat-treated test-bars, has given a tensile strength in excess of 40 tons per sq. in., associated with an elongation of 15 per cent.

Nickel, either in the form of pellets or as 50:50 cupro-nickel alloy-shot, dissolves quite readily in molten copper at a temperature well below its own melting point. It may either be added with the charge or to the copper when molten. No loss is normally experienced in re-melting. Nickel raises the melting point of bronzes without appreciably affecting the freezing range. This fact does not, however, introduce difficulties, since nickel appears to have a fluidising action on bronze, and although the value of this is difficult to assess quantitatively in the foundry, laboratory spiral fluidity tests have shown increased lengths of run up to 40 per cent., resulting from an addition of 0.5 per cent. of nickel. The magnitude of this effect increases with the nickel content up to a certain moderate percentage of nickel and varies considerably with the basis mixture.

The number of different compositions used at present is too large to give in great detail here, but some representative compositions will be taken and the type of purpose for which they are suitable indicated.

Gunmetal Types

For general purposes, modifications of the 88:10:2 and 88:8:4 types of alloys are widely used. Up to 5 per cent. nickel may be substituted for tin or added direct, giving an improvement in strength properties and ductility. An interesting point established in America is the fact that for castings which require to be subsequently nickel and chromium plated, the finer grain of the nickel-bronze casting enables a better adhesion of the deposit to be secured. No systematic determination of the corrosion-resistance or erosion-resistance of nickel-containing bronzes has been made, but it has been frequently reported that improvements over a straight bronze have been obtained, and this has been attributed in part, not to any change in what might be called inherent resistance, but to the denseness and fine grain of the casting itself. Where the bearing property of a bronze is of prime importance, care must be exercised in the use of nickel percentages in excess of one or two per cent., since, in some circumstances, the addition of higher percentages of nickel than this adversely affects the bearing property. In addition, more adequate feeding may be necessary; it is generally recommended that 0.04 per cent. of phosphorus be added to deoxidise these higher nickel alloys.

The 88:5:5:2 copper-tin-nickel-zinc alloy has been extensively used for catenary clamps and trolley-wire hinges in railway electrification schemes abroad and, after a heat-treatment such as described above, the alloy is used for heavy-duty electric circuit breakers. The 88:4:4:4 copper-nickel-tin-zinc alloy is a general all-purpose alloy, conveniently handled in the foundry and largely used for fittings in the marine field. In lead-containing alloys for anti-frictional bearing purposes, nickel is included in the whole range of compositions. Typical alloys for medium and heavy loads are 80:11:1:1, 80:8:10:2, 70:6:15:1 copper-tin-lead-nickel. The last also contains ½ per cent. of zinc, and is used for railway carriage bearings. In pressure castings of the red-brass type, 1 per cent. nickel is used in such articles as plumbing fittings, valves, etc., to increase pressure tightness. High-duty worm-wheel phosphor-bronzes, containing in general 10 to 11 per cent. tin, 0.2 to 0.5 per cent. phosphorus, usually contain 0.5 to 1 per cent. of nickel; the nickel addition has been found useful in centrifugal castings to give shock resistance in thin sections, whilst it also prevents excessive grain growth in heavy sand-cast sections. Wear resistance is a further property which benefits from nickel additions to this type of material.

Aluminium-Bronze

The difficulties associated with the production of good sand castings in aluminium-bronzes have seriously limited their application and the valuable strength and corrosion-resisting properties of this series of alloys have consequently not been fully utilised. Whilst the systematic attention given to the effect of nickel in tin-bronzes has not been paid to its effect in the corresponding aluminium-containing alloys, nickel is known to exert an interesting influence on the physical and mechanical properties of the alloys, and in some cases with high nickel contents completely to change the nature of the heat-treatment required to produce maximum strength and hardness. Quenching softens such alloys and re-heating hardens them, the reverse procedure of normal aluminium-bronze castings.

The " self-annealing " or embrittlement occurring during the comparatively slow cooling of some aluminium-bronze sand castings can, as is well known, be overcome by the addition of 3 to 4 per cent. of iron, nickel or combined nickel and iron additions, and this constitutes one of the reasons for the presence of nickel. In chill or die castings, where cooling is too rapid to enable the embrittling $\beta \rightarrow \alpha + \delta$ change to occur, nickel is added, in conjunction with iron, to give maximum mechanical and elastic properties.

Smaller percentages of nickel, *e.g.*, 1 to 3, are used in the general run of aluminium-bronze compositions, and it has been stated that in addition to the strengthening effect, nickel helps to ensure a close, dense, fine-grained alloy, suitable for hydraulic castings.

In castings, 7 per cent. of nickel is generally considered to be the upper limit, beyond which, although the tensile strength may further increase, a sharp decline in ductility occurs. The alloy containing 10 per cent. aluminium and 5 per cent. nickel has been found to have excellent all-round properties, particularly from the point of view of resisting sea water corrosion, in which direction the presence of nickel is specially helpful. A similar alloy with 5 per cent. iron and nickel developed under the name of Superston L189 has the following properties as sand-cast:—

Maximum stress	..	42 to 45 tons per sq. in.
Yield point ..	..	22 tons per sq. in.
Elongation on 2 in.	..	15 per cent.
B.H.N. ..	..	160 to 190.
Fatigue strength	..	15 tons per sq. in.

Die-castings of nickel-aluminium bronzes are widely used for automobile parts, motor boat fittings, etc. Alloys such as Superston L189 mentioned above, due to their resistance to chemical reagents, find use in the chemical industry for valves, in the paper industry and for many acid-resisting purposes.

Nickel-Brass and the Nickel-Silvers

The high-tensile brasses or manganese-bronzes owe their excellent mechanical properties to a large extent to small percentages of added elements, of which nickel is, in certain instances, one. On the basis of Guillet's well-known and widely used " coefficients of equivalence," 1 per cent. of nickel is equivalent to − 1.3 per cent. of zinc, *i.e.*, it acts as copper and tends to increase the α content of the alloy, differing in this respect from elements such as aluminium, tin and iron, which have the opposite effect. The data available on the effect of nickel and, in fact, of other elements on the cast high-tensile brasses are not altogether conclusive, due in part to the fact that the direct effect of the added element may have been masked by the change in the relative amounts of α and β present.

Guillet, Smalley and Sturney have all studied the effect of nickel and have established that a useful range of alloys can be obtained by adding this element, which, as would be expected from a negative coefficient of equivalence, has, unlike aluminium, no outstanding effect on the mechanical properties, but results in improvements in other directions.

In quaternary and the more complex high tensile brasses, nickel improves ductility, and an alloy of this nature, known as " Turbadium " bronze (containing 45 per cent. of zinc, 2 per

cent. of nickel with smaller percentages of iron, tin and manganese), has in the sand-cast condition a tensile strength of over 40 tons per sq. in. combined with good ductility. This bronze has been used particularly for marine propellers, as it withstands well the erosive action of sea water.

With a four to one nickel-aluminium ratio, castings are being made which are susceptible to heat-treatment of the age-hardening type. After heat-treatment such castings have sufficient hardness to make them valuable as non-sparking tools, *e.g.*, hammers.

Pilling and Kihlgren[1] have studied the effect of nickel on a yellow brass containing 70 per cent. copper, 1 per cent. tin and 2 per cent. lead, and conclude that this mixture is distinctly improved by nickel additions, with no indication that the useful effect of nickel terminates at any low percentage. Three per cent. of nickel increased the tensile strength, under standard conditions of experiment, by as much as 28 per cent., maintained good elongation and substantially improved compressive properties.

It is of interest to mention here a special brass developed under the name of "Tungum," which contains over 80 per cent. of copper, with small amounts of silicon and aluminium and approximately 1 per cent. of nickel. In the as-cast condition, this alloy has a tensile strength of 24 tons per sq. in., with an elongation of 37 per cent., and is particularly noteworthy for its resistance to corrosion.

The nickel-silvers have been grouped with the brasses, because they can conveniently be considered as brasses to which substantial percentages of nickel have been added. The popularity of the nickel-copper-zinc group of alloys lies in the fact that they represent the most economical casting alloys available possessing a white colour, good hardness and mechanical properties and corrosion resistance, and do not give rise to much difficulty in the foundry. In certain cases trouble may have been experienced in obtaining sound castings in nickel-silver, but this can largely be attributed to the fact that straightforward brass-foundry practice has been applied, whereas, by a few simple modifications of this practice, very little difficulty need be encountered.

Until the last few years the so-called white-metal castings used for plumbing fittings contained perhaps a maximum of 12 per cent. nickel; such castings, although appreciably whiter than brass, could not truly be called "white." A move was therefore made towards increasing the nickel content to give a whiter alloy, until the present day practice of using a minimum of 20 per cent. nickel has become standardised for general casting work. By modifying the nickel content, however, colour matches may be made with the more yellow extruded nickel-silver sections used for architectural purposes and with the bluer tinge associated with the stainless steels.

A typical modern nickel-silver alloy for making castings has a composition as follows:—

Nickel	.. ..	18 to 22 per cent.
Copper	.. ..	50 to 55 ,,
Zinc	.. ..	20 to 25 ,,
Lead	.. ..	0 to 5 ,,
Tin	.. ..	0 to 2 ,,

In America the practice is to use a lower zinc alloy and the standard U.S. Government specification No. W.W.P. 541 calls for the following:—

Nickel	.. .. ..	20 per cent.
Copper	.. .. ..	65 ,,
Zinc	.. .. ..	6 ,,
Lead	.. .. ..	5 ,,
Tin	.. .. ..	4 ,,

Lead is frequently intentionally present in cast nickel-silvers where ease of machining rather than tensile strength is of primary importance. It is often more economical, for instance, to cast a leaded rod required for screwed tap-spindles than to use a drawn or rolled leaded rod, the production of which entails some difficulty. Whether or not lead helps in the production of sound castings is still a debatable point, but since it stays out of solution it helps to break up the structure, thus aiding machining. Tin is said to increase the fluidity of nickel-silvers and to assist in the production of sound castings. It has a slight hardening effect on the alloys.

Iron is an element to which some attention has recently been given in connection with nickel-silvers, and it is in fact sometimes used up to about 5 per cent. Apart from increasing the tensile strength, it has recently been shown that iron brings out certain characteristics useful in the food handling industry; for instance, it prevents the accumulation of scum or fog on the surface, although having a general tendency to decrease the tarnish resistance. Clean tin cans or Armco iron sheet are used for making the iron addition. For normal purposes, iron is regarded as an impurity to be kept as low as possible.

With regard to the remaining impurities, oxygen is definitely harmful, and steps for deoxidising nickel-silver melts are necessary if sound castings are to be obtained. Sulphur, as in other nickel alloys, should be kept at a minimum, that is not more than 0.035 per cent. Silicon and aluminium, which are occasionally used as deoxidants, have a hardening effect if present in excess, and silicon is said to be detrimental to the pressure-tightness of the alloy.

TABLE I.—*Properties of Some Typical Nickel-Bronzes.*

Composition.					Y.P. Tons per sq. in.	M.S. Tons per sq. in.	E. Per cent.	B.H.N.	Remarks.
Ni.	Cu.	Sn.	Pb.	Zn.					
5	88	5	—	2	9	21	34	86	
5	88	5	—	2	29	38	38	136–171	By heat-treatment.
4	88	4	—	4	—	21	30	—	
3	87.75	8	1.25	—	—	15	12	90	
*1	88.25	10.5	—	—	8–14	14–22	8–30	70–85	Phosphorus 0.25 per cent.
*0.5	88	11.2	—	—	12–16	18–22	5–15	90–105	,, 0.3 per cent. Centrifugal castings
*1	81.7	12	5	—	10–14	13–18	4–10	70–80	Phosphorus 0.3 per cent.
*1	80.7	10	8	—	10–12	14–17	6–12	65–75	,, ,, ,,
*1	76.7	10	12	—	6–7	13–18	20–30	45–55	,, ,, ,,
1	84	6	3	6	—	16	27	65	
2.5	85	2.5	9	1	—	12	12	—	
1	69	5	25	—	—	10	17	47	Chill Cast.
7	77	5	3–6	8	—	9 min.	9 min.	—	
14	74	4	—	8	12 min.	22 min.	11 min.	—	

* By courtesy—David Brown & Sons (Hudd.), Limited.

Incidentally, the presence of substantial quantities of aluminium, *e.g.*, over 1 per cent., may render the alloy susceptible to heat-treatment. Excess phosphorus, another deoxidant, results in a hardening and embrittlement of the alloy. Carbon is also undesirable, although more so in worked alloys than in cast alloys. The two elements the influence of which is beneficial are manganese and magnesium. The former is usually intentionally added up to a quarter per cent. for deoxidation purposes, and a final small addition of the latter helps to finish the deoxidation process and to supplement the effect of manganese, by combining with and rendering inocuous any sulphur that might be present. Excess magnesium leads, however, to "dirty" metal. Manganese appears to have no obvious effect on the physical properties of the alloys, other than that brought about by the elimination of unsoundness, etc.

Little attention has so far been given to the mechanical properties of the nickel-silvers in the cast condition, no doubt because the principal applications of nickel-silver castings have been decorative and the alloys are not so widely used for engineering purposes. Depending on pouring temperature and the lead and other alloy contents, quite useful strengths in the region of 20 tons per sq. in. are possessed by these alloys, the elongation averaging 10 to 25 per cent. for lead-containing alloys and up to 40 per cent. for lead-free alloys. The Binell hardness number of the 20 per cent. alloy is usually of the order of 75, but by adjusting the composition higher hardnesses are obtainable.

It is now generally recognised that whatever degree of stainlessness and tarnish-resistance a metal possesses, it is necessary to clean it occasionally, if only to remove the dirt accumulated on the surface. This being the case, it is often preferred nowadays to use a soft, coloured metal, such as one of the nickel-silvers, which, although not having the degree of corrosion-resistance of the more truly corrosion-resistant and harder-toned alloys, can be maintained in good condition with very little attention. The tarnish-resistance of the nickel-silvers increases with the nickel content and to a lesser extent with the zinc content. The effect of lead on this property has been found, under laboratory conditions of test, to be slight, but small additions of tin appear to have some benefit. As compared with brass, the nickel-silvers may be regarded as corrosion-resistant materials, and they do in fact give good service under marine and other atmospheric conditions.

Production of Sound Nickel-Silver Castings

In this connection it is important to remember that nickel-containing alloys are particularly susceptible to the absorption of harmful impurities and gases from the furnace, and it is therefore advisable to keep the melting time to a minimum, and everything possible should be done to this end. In addition, steps should be taken to protect the metal from atmosphere during melting.

Natural or forced-draft crucible furnaces are generally used for melting nickel-silver for sand castings, and provided a strong draft is available and coke is used that does not burn away too quickly, these furnaces are satisfactory. Oil and gas furnaces can be used with advantage, but electric melting methods, either of the resistance, induction or arc type, have not so far been used to any extent in the nickel-silver foundry, although some success has been achieved with the rocking-arc furnace. The high-frequency induction furnace has, also, recently been employed with excellent results for making nickel-silver ingots for rolling.

The charge may be composed of ingot metal, virgin metal or a combination of either of these with scrap, but the latter should not exceed 50 per cent. of the charge and should be carefully selected. No excessive zinc loss is experienced when this is put in with the original charge, but lead should not be added until just before pouring. It is advisable to use a cover, and for this purpose an 80:20 mixture of borax and boracic acid is suitable or a proprietary flux known as "Borocalcite." Glass may also be used, and although not such a good flux, is less severe on crucibles. In the choice of the latter the smallest size which will take the charge should be used in order to prevent undue variation in pouring temperature. Either carborundum or graphite crucibles give good results, but

it is important that these should not be continued to be used after, say, 20 heats; after this stage poor castings may result, due to the fact that the pots get thin and transmit more furnace gases into the melt, also the pots do not hold their temperature so well during pouring. When molten an addition of 2 ozs. of manganese per 100 lbs. of metal should be made for the purpose of deoxidation. This can be added as metallic manganese or as cupro-manganese. A few minutes should be allowed to lapse between the addition of the manganese and pouring, and it may be advisable just before pouring to make a small addition of metallic magnesium, say ¼ oz. per 100 lbs. of metal. So that the magnesium does not burn away on the surface, it should be attached to an iron rod and plunged rapidly into the melt. The recommended deoxidation technique for the American-type alloy referred to above, is the successive addition of 0.10 per cent. manganese, 0.05 per cent. magnesium and finally 0.02 per cent. phosphorus.

Many of the faults found in nickel-silver castings are associated with the moulding technique rather than with the preparation of the molten metal. The use of unsuitable sands for moulds and cores, insufficient feeding, sudden changes of section, wrong pouring temperature and lack of adequate venting are common causes of faulty nickel-silver castings that are not difficult to remedy.

Highly-refractory open sands are necessary and moulds should be generously vented. For light castings, well-ventilated fine sands are used. For cores, bronze-founding practice can be successfully followed, and generally cores used should be collapsible. Plumbago mould facings containing loam, china clay or molasses are applicable to this type of work.

The nickel-silvers have a high shrinkage, and it is important to make adequate provision for feeding castings, heads considerably larger than those required for other copper-base alloys being required. It has been found advisable to lay out nickel-silver castings with a smaller number of pieces per gate than would be considered good practice on ordinary brass work. Whilst it is not easy, due to pyrometer difficulties, to keep a constant check on the pouring temperature, it is desirable not to vary appreciably from 1,250 deg. C. for the 20 per cent. nickel alloy and to pour fairly rapidly.

Progress in the pressure die-casting of nickel-silvers is being made, and for this purpose the zinc content is increased to give an alloy of maximum whiteness with minimum melting point.

A typical composition is as follows:—

Nickel	16 per cent.
Copper	42 ,,
Zinc	41 ,,
Lead	1 ,,

This is an alloy of $\alpha + \beta$ structure and melts at a temperature below 1,000 deg. C. A high-tungsten steel is used for the dies. Developments might be expected in the application of die-castings in this type of material.

Nickel-silver castings, in general, are used for all kinds of plumbing fittings, taps, brackets, etc., valves and cocks for food-handling plant and for general architectural metal work. In the latter connection, if it is desired to weld the casting to a wrought product, lead should be omitted from the composition, since this element promotes cracking during the welding operation.

Zinc-Base Alloys

The effect of nickel in zinc-base die-castings is of particular interest because of the likelihood of nickel or nickel-plus-chromium plated scrap being occasionally present in the charge. From this point of view nickel, if it goes into solution at all, is not regarded as deleterious, and it is not essential, as is the case with lead, tin and cadmium, to place strict limits on its presence. Nickel acts like copper and magnesium in retarding the decomposition of the unstable β constituent into α and γ. As is well known, this decomposition is accompanied by a volume change and results in microscopic cracks and a strong liability of the castings to intercrystalline corrosion.

Up to 0.3 per cent. of nickel is being used to a limited extent in zinc-base die-castings of the usual aluminium and copper and magnesium contents, but the effect of nickel in preventing intercrystalline oxidation is not as great as that of magnesium alone. Although comparative figures on the effect of nickel on the mechanical properties of zinc-base die-castings are lacking, it is said to give a mild improvement in the tensile strength and impact values without loss in elongation. Since the melting point of nickel is so much higher than that of zinc, difficulty might be expected in getting the nickel into the alloy. Actually by using an intermediate alloy, *e.g.*, of nickel and aluminium, no trouble is normally experienced.

Tin-Base Alloys

The *rôle* of nickel in tin-base bearing metals is still a matter of some controversy. Its presence is not considered harmful, and it is, indeed, actually the practice in some instances to incorporate a small percentage of it in tin-base alloys.

It has been stated that nickel increases the ductility and eliminates the tendency to cracking without impairing the wearing qualities, but evidence in support of this statement is somewhat contradictory. Increase in the copper content appears to be necessary to counteract the effect of nickel in combining with the copper and consequently suppressing the formation of the strength-giving copper-tin needles. High percentages of nickel, *e.g.*, 5 per cent., give an appreciable increase in hardness but, owing to the formation of the compound Ni_3Sn_2, such additions lead to unfavourable impact properties.

In some standard specifications,[4] nickel is specified and indeed is often present up to 0.6 per cent., although 0.25 per cent. nickel is a more usual percentage. An alloy containing 0.25 per cent. of nickel, 7.5 per cent. antimony and 2.25 per cent. copper is in use in America for motor vehicle bearings subjected to heavy loadings and high speeds. It has a Brinell hardness number of 26.

Lead-Base Alloys

The position of nickel in relation to lead-base bearing alloys is rather more definite than in the case of the tin-base alloys in that it has an established function. Widespread efforts have been made to devise a lead-base bearing metal which would have properties comparable with those of the tin-base alloys, and experiments have taken the direction of the improvement of ternary lead-antimony-tin alloys by the addition of further elements. As a result the well-known "Thermit" alloy has been developed. Thermit (or Eel Brand) has the following approximate composition:—

Antimony ..	14 to 16 per cent.
Tin	5 to 7 ,,
Copper	0.8 to 1.2 per cent.
Nickel	0.7 to 1.5 ,,
Arsenic	0.3 to 0.8 ,,
Cadmium ..	0.7 to 1.5 ,,
Lead	72 to 78.5 ,,

The nickel combines with antimony and the compound so formed acts as a hardening agent. Best results are obtained if the nickel content does not exceed 10 per cent. of the antimony content. Nickel also raises the softening temperature of the alloy to approximately 230 deg. C. Certain precautions in tinning and casting must be taken but it is a useful alloy for general purposes, and has been particularly successful for cold-rolling mill bearings and turbo-generator journal bearings. It has a comparatively high compressive-strength and a Brinell hardness of 29, from which it can be seen that from a hardness point of view it compares favourably with the tin-base alloys.

(*To be concluded.*)

[4] (DTD 214 Antimony 6.5 to 7.5 per cent., copper 3.0 to 4.25 per cent., nickel up to 0.6 per cent., tin balance.)
(DTD 244 Antimony 6.0 to 7.0 per cent., copper 5.5 to 7.5 per cent., nickel up to 0.6 per cent., tin balance.)
(2B22 Antimony 3.5 to 4.0 per cent., copper 3.75 to 4.25 per cent., nickel up to 0.6 per cent., tin balance.)

The Problem of the Elimination of Gaseous Impurities from Aluminium

(*Concluded from page* 510.)

whilst the atmosphere above the crucible was air which could only be renewed with difficulty because the refractory tube employed as a muffle was carefully closed with an asbestos plug. From the figures in the second column of Table V, it will be seen that a very slight formation of nitride occurs between 900 and 950 deg. C., but the action of the nitrogen (molecular nitrogen) is only rapid well above 1,000 deg. C., as may be seen from experiment 8 of Table IV. Hydrogen and carbon monoxide combine much more rapidly with aluminium even at 950 deg. C., as shown by experiments 3 and 4 of Table IV. Nitrogen, or more exactly nitrides, are therefore not the only cause of the spitting of aluminium.

TABLE V.—*Showing Influence of Temperature.*

Nature of the metal and treatment.	N_2 ml. per 100 grams.	"Bell-jar" test.
Original metal	4.8	No gas evolved.
Same metal melted in the gas furnace (T. 900 to 950 deg. C.)	10.3	Gas evolved.
Same metal melted in the electric furnace (T. 900 to 950 deg. C.)—		
1st melting	4.8	No gas evolved.
2nd ,, ...	5.2	,, ,,
3rd	5.2	,, ,,
4th ,, ...	5 6	,, ,,

These experiments clearly show that the solubility of the hydrides, carbonyls and nitrides of aluminium increases with the temperature, but that this solubility is still very high in the liquid state in the vicinity of the melting point, and even in the solid state. The sole effect of practical methods of degasification is therefore to destroy the supersaturation acquired at high temperatures. It would certainly appear that the foundryman has nothing to fear from gases properly dissolved in the metal (that is to say, in equilibrium with the latter). The author will not give any advice from the practical point of view, but certain conclusions follow from these experiments:—(1) Overheating of the aluminium is the first enemy of the foundryman; and (2) gases of combustion must not come in contact with the metal.

Catalogue Received

Pneumatic Conveying. Davidson & Company, Limited, of Belfast, Northern Ireland, in Publication No. S.F. 209, deal very exhaustively with the problem of handling and transporting materials in divided form. So far as the foundry industry is concerned, one main problem is that of conveying sawdust from the patternshop to, say, the boilers or gas producers. For the other major problem in the industry—that of dust removal, the Sirocco products are, of course, well known and appreciated. The particular brochure is more than a mere catalogue; it is a veritable text-book, starting off with "Historical" and terminating in specific examples of industrial treatment. It contains about 60 well-illustrated pages and is certainly worthy of a place in any library of trade literature as a serious contribution to a specific subject.

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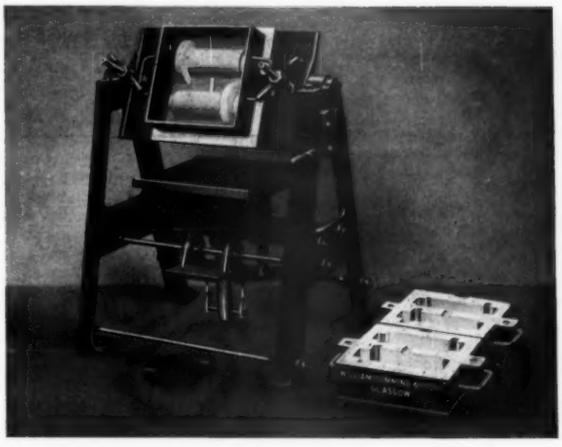

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This Week's News in Brief

Trade Talk

MEMBERS AND FRIENDS of the counting house staff of the Carron Company, Falkirk, held their annual outing last week.

AN ORDER FOR A 7,300-ton cargo vessel for Whitby (Yorkshire) owners has been received by W. Bickersgill & Sons, of Sunderland.

THE "JUBILEE" No. 3 furnace at the Millom Ironworks is to be restarted in about a fortnight's time. The furnace has been relined.

EMPLOYEES AT THE Lochaber and Kinlochleven works of the British Aluminium Company, Limited, are to have their annual holidays with pay.

GLENFIELD & KENNEDY, LIMITED, Kilmarnock, are to supply steel sluice gates to Pershore, Stratford and Barford for the Severn Catchment Board.

A MOULD WHICH EXPLODED at the works of the East Ferry Engineering Company, Millwall, London, last Thursday, injured Mr. A. Shackleton, a foreman moulder.

THE OFFICE AND WORKS STAFF of R. & A. Main, Limited, Gothic Iron Works, Falkirk, were the guests of the firm on an all-day excursion to Glencoe on June 6.

KING FAROUK OF EGYPT visited the Corby Works of Stewarts and Lloyds, Limited, last week, and was shown round by the managing director, Mr. J. R Menzies-Wilson.

THE SHEFFIELD SOCIETY OF ENGINEERS AND METALLURGISTS are to visit the Park Works of David Brown & Sons (Hudd.), Limited, Crosland Moor, Huddersfield, on June 30.

THE B. & S. SHIPPING COMPANY, of Cardiff, has placed an order with J. L. Thompson & Sons, Sunderland, for a 9,000-ton cargo steamer. The engines will be installed by White's Marine Engineering Company, Hebburn-on-Tyne.

THE L.N.E.R. HAVE DECIDED to reorganise the system of working at their wagon-repair shops at Temple Mills, Stratford, so that in future a progressive system of repairs may be carried out. The damaged wagons will enter the shops at one end, and after each process has been completed will move forward until they emerge ready for traffic again.

THE FIRM OF A. Viaslov, of Bucharest, Rumania, has placed orders with Bartram & Sons, Limited, and W. Doxford & Sons, Limited, of Sunderland, for two ships. The vessel built by Bartrams will be engined by the North-Eastern Marine Engineering Company, Limited, Wallsend, and the other by Richardson, Westgarth & Company, Limited, Hartlepool.

A CONFERENCE ON MAGNETISM will be held in the Physics Department of the University of Manchester on July 1 and 2, under the auspices of the Manchester and District Branch of the Institute of Physics. Prof. W. L. Bragg, F.Inst.P., F.R.S., chairman of the Branch, will preside over the conference, and amongst the lectures to be given are the following:—"Permanent Magnets," by Mr. D. A. Oliver; "Influence of the Properties of Available Magnetic Materials on Engineering Designs," by Dr. C. Dannatt; "X-Ray Studies on Permanent Magnets of Iron, Nickel and Aluminium," by Dr. A. J. Bradley. Further particulars may be obtained from Dr. C. Sykes, F.Inst.P., Research Department, Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, 17.

Birmingham Aluminium Casting Company

In the Chancery Division last week, Mr. Justice Crossman confirmed a reduction of the capital of the Birmingham Aluminium Casting (1903) Company, Limited, from £300,000 to £75,000, to be effected by the return to the shareholders of £225,000, which is in excess of the company's wants.

Mr. Evershed, K.C. (for the company), said the shares were all of one class. The balance-sheet showed that the company had surplus assets over liabilities of £270,000, which could not be usefully employed in the business. It had valuable investments in subsidiary companies, and the proposal was to use the shares of these subsidiary companies to satisfy the return of capital.

Personal

DR. H. NIPPER, the well-known foundry metallurgist, has left the Aachen Technical College to take up a Government position in Berlin.

MR. W. A. GEISLER, a German member of the Institute of British Foundrymen, has left Frankfurt-on-Main to join the staff of Krupps, of Essen.

DR. A. B. EVEREST is presenting a Paper to the Annual Conference of the Society of Chemical Industry, to be held in Harrogate from July 5 to 9.

MR. TOM STIRLING, of Gowan Avenue, Falkirk, who has been President, Vice-President and treasurer of the Ironmoulders' Association, celebrated his golden wedding on June 10.

MR. ALAN E. L. CHORLTON, M.P., has joined the board of Edward Wood & Company, Limited, structural engineers, of Trafford Park, Manchester, and has been appointed chairman to succeed the late Mr. R. C. Irwin.

MR. ARCHIBALD ADAM, for the last 20 years in the employ of the Shotts Iron Company, and Mr. Charles Graham, a moulder, who retired a few years ago from the service of the same company, have just celebrated their golden weddings.

MR. A. G. SIMS, governing director of Albert G. Sims Proprietary, Limited, Sydney, N.S.W., is at present in London and would like to meet manufactures or others wishing to make connections with Australia. Letters may be sent care of the Editor.

SIR JOHN JARVIS is to have the honorary degree of D.C.L. conferred upon him by Durham University in connection with the centenary celebrations. Sir John Jarvis has been active over a long period in endeavours to bring a revival of industry to Jarrow.

MR. H. WATSON-JONES has relinquished his position with the Metropolitan-Vickers Electrical Company, Limited, to take up that of manager of the Birtley Company, Limited, Durham. Educated at Liverpool College and Liverpool University, Mr. Watson-Jones had his early practical training with the Mersey Docks and Harbour Board. He has been with the Metropolitan-Vickers Company since 1923, first as post-graduate apprentice, later on installation work and in the U.S.A. as the company's liaison engineer for technical developments. His recent work has been on general engineering in connection with contracts for large power stations and power supply for railway electrification.

Wills

CLARK, WILLIAM, of Skelmorlie, Ayrshire, formerly managing director of Vickers' River Don Works, Sheffield, and a former Master Cutler £56,464

LANG, J. J., chairman of P. MacCallum & Sons, Limited, iron and steel merchants and shipowners, Greenock, and of John Hastie & Company, Limited, engineers £172,412

Obituary

MR. J. A. V. THOMSON, a works engineer of the British Aluminium Company, Limited, at Kinlochleven, has died.

MR. DAVID R. HUNTER, managing director of the Arbroath Foundry Company, Limited, died on June 9, aged 61.

MR. A. F. JELLYMAN, head of the Cannock Foundry and General Engineering Works, Cannock, Staffs, has died, aged 81.

MR. WILLIAM DOUGLAS, founder and managing director of the Douglas Firebrick Company, Limited, Dalry, Ayrshire, has died at the age of 82.

MR. CHARLES HAMPTON, founder and chairman of C. & J. Hampton, Limited, tool manufacturers, Record Works, Sheffield, has died, at the age of 74. Mr. Hampton founded the firm on going to Sheffield from Wednesbury in 1898.

MR. S. MARRIOTT, of Sheffield, has died. Mr. Marriott had been associated with Thos. W. Ward, Limited, for a number of years, and for the last ten years was representative for George Cooper & Sons, Effingham Nut and Bolt Works, one of their subsidiary companies.

Company Reports

Turner & Newall, Limited.—Interim dividend of 3½ per cent. actual.

R. A. Lister & Company, Limited.—Interim dividend of 5 per cent.

Cannon Iron Foundries, Limited.—Interim dividend of 5 per cent. on the ordinary shares.

Electric Furnace Company, Limited.—Final dividend of 5½ per cent., making 8 per cent. for the year.

Whessoe Foundry & Engineering Company, Limited.—Dividend of 20 per cent. for the year to March 31.

Guest, Keen & Nettlefolds, Limited.—Profit, after charging debenture interest, £64,662, and making provision out of profits for redemption of debenture stock amounting to £37,135, of £1,048,727; from provision for wear and tear, £75,000; obsolescence, £75,000; provision for writing-off under works reorganisation schemes, £150,000; final dividend on the ordinary stock of 3½ per cent., free of tax, making 6 per cent. tax free, for the year.

Consett Iron Company, Limited.—Profit for year to March 31, before depreciation and debenture interest, £722,074; interest on debenture stock, £85,312; brought in, £106,488; depreciation, £125,000; 8 per cent. preference dividend, £40,000; dividend of 7½ per cent. on the ordinary stock, £210,000; in meeting drawing for redemption of 4½ per cent. debenture stock paid on April 1 last, £26,750; further provision towards a reserve for improvement and extension of plant and machinery, etc., £200,000; carried forward, £141,499.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Beech & Bird, Limited, 71, Sams Lane, West Bromwich.—Capital, £500. Brassfounders, general engineers, etc.

Gladiator Welder Sets, Limited, 18, Leicester Road, Sale, Ches.—Capital, £1,200. Directors: H. Pollock and Mrs. L. B. Pollock.

Applications for Trade Marks

The following list of applications to register trade marks has been taken from the "Trade Marks Journal":—

"KOVAR."—Metallic alloys. Westinghouse Electric & Manufacturing Company, c/o G. Raymond Shepherd, 2, Norfolk Street, Strand, London, W.C.2.

"MEPHOS."—Unwrought and partly-wrought metals. British Pigirons, Limited, Abbey House, 2, Victoria Street, London, S.W.1.

"FRASER & CHALMERS ENGINEERING WORKS."—Turbines, boilers, winding engines, conveying machines, wagon-tipping machines, coal-washing and cleaning machines, rolling mills, plate-bending and straightening machines, etc. General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2.

ACE (DEVICE).—Metal clips or couplings for tubular scaffolding A. C. E. Machinery, Limited, 24, Porden Road, Brixton, London, S.W.2.

"ARDOLOY" AND "ADOLOY."—Metal dies without a cutting edge. British Thomson-Houston Company, Limited, Crown House, Aldwych, London, W.C.2.

"NITRESTO."—Packing and jointing. James Walker & Company, Limited, Lion Works, Maybury Hill, Woking, Surrey.

"MAXCISION."—Cutlery and edge tools. British Tap & Die Company, Limited, Triangle Works, Town Road, Edmonton, London, N.9.

"TEENSTEEL."—Steel belt fasteners. N. V. Metalgelria, c/o Marks & Clerk, 57 and 58, Lincoln's Inn Fields, London, W.C.2.

"BRIVADIUM."—Piston rings, unwrought and partly-wrought metals. British Piston Ring Company, Limited, Holbrook Lane, Coventry.

"DONBRO."—Metal goods. Donald Brown & Company (Engineers), Limited, Blaydon Iron Works, Tyne Street, Blaydon, Durham.

"CENTAUR."—Machine tools. Coventry Machine Tool Works, Limited, St. George's Road, Coventry.

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Raw Material Markets

While there has been a fair amount of new business transacted for delivery in the second half of the year, the demand for iron and steel continues to be much in excess of the production—large though the latter undoubtedly is. Offers for British material from abroad are still received, and frequently overseas consumers intimate their willingness to pay enhanced figures, but producers are adhering to their policy of satisfying the home demand first.

Pig-Iron

MIDDLESBROUGH.—Producers have not proved too willing to enter into new business over the second half of the year, as arrears in deliveries are still extensive. After the demands of the steelworks have been met, there is very little iron left for disposal. Export inquiries are also having to be neglected. Second half of the year trade will be governed by the following quotations :—No. 4 foundry and No. 4 forge, 100s.; No. 3 G.M.B. iron, 101s.; No. 1 foundry, 103s. 6d. No. 3 G.M.B. will be 104s. in the Falkirk area and 107s. on Clydeside. The demand for hematite continues to be far in excess of the available supply, and only a small proportion of the inquiries can be accepted. Mixed numbers are quoted at 122s. 6d., less 5s. rebate, for local delivery, 128s. in Sheffield and 133s. 6d. in the Midlands.

LANCASHIRE.—Consumers in this area are having to be content with supplies composed of several qualities of foundry iron. Deliveries are still inadequate to meet the full needs of users. For delivery to consumers in the Lancashire price zone during the second half of the year, Derbyshire and Staffordshire brands of No. 3 foundry iron are quoted on the basis of 109s., with Northamptonshire No. 3 at 107s. 6d. and Derbyshire forge iron at from 104s. to 106s. West Coast hematite is quoted at 131s. and East Coast at 130s. 6d., while Scottish foundry iron is at present quoted at 136s. per ton.

MIDLANDS.—A fair amount of business continues to be arranged in Northamptonshire iron for July-September delivery, and in Derbyshire material for delivery in the last quarter. New contracts are usually based on 1936 orders, but it is not always possible to secure even this treatment from producers, who are stepping warily as to the future. It must not be overlooked that at the present time stocks are non-existent, whereas last year they played an important part in making up deliveries. Continental high-phosphoric iron is being taken up at from £7 15s. to £8 per ton, delivered the Midlands, while some low-phosphorus iron from the United States has already changed hands at up to £8 5s. For deliveries to Birmingham and Black Country stations on and after July 1, Northants No. 3 iron will be invoiced at 103s. 6d., with Derbyshire, Lincolnshire and North Staffordshire iron at 106s. Forge pig-iron will be 3s. to 5s. per ton less than the foregoing figures. While consumers of special-grade irons are fairly well stocked, there is little further material to be obtained. The controlled prices of hematite, delivered to Birmingham and Black Country stations, are £6 14s. 6d. for West Coast mixed numbers and £6 13s. 6d. for East Coast No. 3, subject to 5s. rebate and an extra 1s. 6d. per ton if delivered into works. Some users of hematite have been able to make contracts for supplies up to the end of the year, but many furnaces are unwilling to book so far ahead.

SCOTLAND.—Imports of pig-iron from the United States have arrived in this area, and have given some measure of relief to consumers, whose requirements cannot wholly be met by the current production. Stocks, both at the consumers' yards and the producing end, are exceedingly difficult to find. No. 1 foundry is quoted at 115s. 6d. per ton and No. 3 at 113s., f.o.t. furnaces. New business in Cleveland iron is difficult to arrange, and delivery arrears are considerable. No. 3 Cleveland is quoted at 104s. f.o.t. Falkirk and 107s. f.o.t. Glasgow. The foregoing figures are for delivery in the second half of the year. Mixed numbers of hematite are quoted at 123s., with British basic at 107s. 6d. and Indian basic at 100s., all delivered steelworks and less 5s. rebate. A good tonnage of Indian basic iron has recently come into the market.

Coke

Negotiations for an international coke convention, which have been in progress for some time between representatives of coke producers in Germany, Holland, Belgium, Poland and the United Kingdom, have been brought to a successful conclusion, and a convention was signed in London on Friday by representatives of producers in the five countries. A Managing Committee has been appointed to operate the convention, and a British Coke Export Sales Association has been formed, to implement the undertaking of the exporters of the United Kingdom under the convention. A National Central Committee has been appointed representative of various districts. The object of the convention is, of course, to regulate export sales, and, meanwhile, demand at home remains keen, and prices still have a rising tendency. Durham furnaces have announced that for delivery to Birmingham and district, their minimum price of foundry coke has been raised to 49s. 7d. per ton. Further, some producers have intimated that they are willing to accept orders for deliveries up to the end of the year. Welsh coke for delivery in the Midlands is quoted from 47s. 6d. up to 62s. 6d. per ton.

Steel

The pressure to obtain supplies of practically all descriptions of steel shows no sign of relaxing, says the official report of the London Iron and Steel Exchange, but, owing to the difficulty of finding producers able to accept orders, the market has a dull appearance and comparatively few transactions have been reported. In the semi-finished steel department, the scarcity of material is still affecting operations at the consuming works. The production of British semis is being pressed to the utmost, but falls short of the demand, while imports, which have been on a slightly higher scale of late, have not been sufficient to meet consumers' requirements. Business in finished steel has been restricted, as many of the makers are booked up to the end of the year, and others cannot take orders for execution earlier than October and November. Export demand is not so active as recently, but there is still a considerable volume of inquiry in circulation.

Scrap

Although the scheme of control has only been in full operation for a short time, there are indications that the measure has already had beneficial effects on the scrap market. There is little or no abatement in the exceptionally heavy demand in all areas, but there can be little doubt that the supply position has eased to some extent, thus facilitating the placing of orders for additional material which was urgently required. In some areas, notably Cleveland and Scotland, the arrival of supplies from abroad has been welcomed, and further tonnages are expected in the near future.

Metals

Copper.—A report from New York states that representatives of additional United States copper producers have sailed for Europe to join the world copper talks in London. Two American representatives were already in London, and the failure of the conference so far to agree on a limitation of production is understood to be the reason behind the decision to send the new delegation. A fair amount of selling and liquidation has again been seen during the past week, and this has been almost entirely due to the uncertainty in regard to the gold position. It is difficult to understand the continued apprehension with which this question is regarded. President Roosevelt has denied knowledge of any intended change, while Sir John Simon, on this side, announced that the British Government intended to make no change in their present financial policy. If the Chancellor of the Exchequer can dismiss the matter as lightly as he did in the House of Commons recently there would hardly seem to be grounds for the current disturbances in business and commercial circles generally. Quiet conditions have ruled in the United States.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £54 18s. 9d. to £55 1s. 3d.; Friday, £54 17s. 6d. to £55; Monday, £54 8s. 9d. to £54 10s.; Tuesday, £51 7s. 6d. to £51 12s. 6d.; Wednesday, £53 10s. to £53 15s.

Three Months.—Thursday, £54 17s. 6d. to £54 18s. 9d.; Friday, £54 15s. to £54 17s. 6d.; Monday, £54 3s. 9d. to £54 5s.; Tuesday, £51 7s. 6d. to £51 12s. 6d.; Wednesday, £53 5s. to £53 7s. 6d.

Tin.—As had been generally anticipated, no change was made in the 110 per cent. tin production quota at the meeting of the International Tin Committee at The Hague on Friday last. The next meeting of the Committee has been fixed provisionally for September 9 in Paris. A fair tonnage has changed hands in this country, and the tinplate industry has continued to be a prominent consumer. Little favour, outside Holland, has been aroused for the suggestion of a buffer pool, which was advocated by the chairman at the recent meeting of the Billiton concern.

Official quotations were as follow :—

Cash.—Thursday, £248 to £248 5s.; Friday, £248 5s. to £248 10s.; Monday, £246 5s. to £246 10s.; Tuesday, £243 to £243 5s.; Wednesday, £247 15s. to £248.

Three Months.—Thursday, £247 to £247 5s.; Friday, £247 5s. to £247 10s.; Monday, £245 10s. to £246; Tuesday, £242 10s. to £242 15s.; Wednesday, £247 to £247 5s.

Spelter.—This market has been almost completely neglected during the past week, and consumers appear to be quite content to draw on stocks. Quiet conditions have also prevailed in the United States.

Daily market prices :—

Ordinary.—Thursday, £20 17s. 6d.; Friday, £20 17s. 6d.; Monday, £20 15s.; Tuesday, £19; Wednesday, £20 5s.

Lead.—Rather featureless conditions have also ruled in this market recently, and there is only a small amount of buying. Consumption is reported to be well maintained.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £22 2s. 6d.; Friday, £22 5s.; Monday, £22 1s. 3d.; Tuesday, £21; Wednesday, £21 18s. 9d.

Publication Received

Some Applications of "Ni-Tensyl." Published by the Bureau of Information on Nickel, Thames House, Millbank, London, S.W.1.

This brochure is particularly interesting as all the illustrations are drawn from American sources, and they show in a very convincing manner the wide-spread application which "Ni-Tensyl" enjoys in that country. Unlike many similar types of publications, really germane data are printed alongside each illustration, changing the aspect from one of passing interest to that of matter well worth filing. The practical realisation of the potentialities of the material could not be more forcibly interpreted.

Development of Foundry Production

Professor N. N. Rubstov writing in "Litenoye Dyelo" gives a review of the primitive methods of the production of iron in Egypt, China and elsewhere and an account of bronze founding in former times. This is followed by a *résumé* of the growth of founding in Russia from early times to the commencement of the 18th century. Details are given of the casting of the famous "Great Bell" of Moscow.

Society of Chemical Industry Conference

Questions ranging from the problems of alloy cast irons to the utilisation of waste fruit will be discussed at the 56th annual meeting of the Society of Chemical Industry which will be held at Harrogate from July 5 to July 9, under the Patronage of the King. It is expected that more than 500 scientists will attend the meeting. They will come from every continent and from practically every industrialised country in the world. The Society's presidential address will be delivered by Lord Leverhulme.

THE METALECTRIC—TAGLIAFERRI

ARC FURNACES

For the melting of

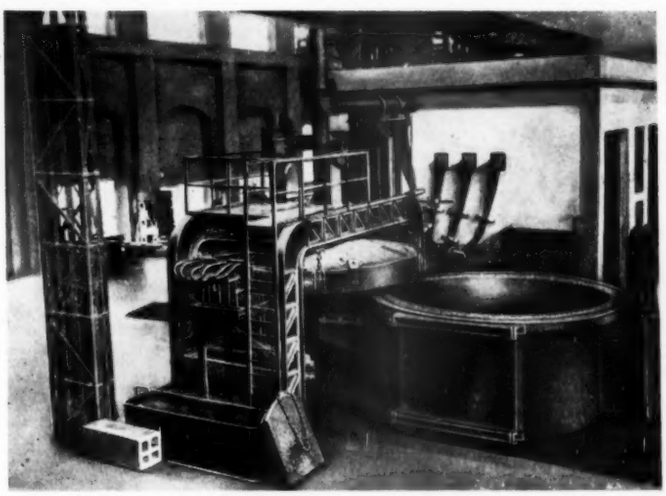
IRON and STEEL

THE METALECTRIC-TAGLIAFERRI FURNACE EMBODIES THE LATEST DEVELOPMENTS IN THE ELECTRIC MELTING OF IRON AND STEEL.

Furnace capacity 1 to 50 tons with or without removable hearth. The Tagliaferri system of control forms part of the equipment in every installation.

120 furnaces have already been installed with a kilo-watt capacity of 250,000.

WRITE NOW FOR PARTICULARS.



METALECTRIC FURNACES LIMITED

Smethwick, Birmingham.

LONDON OFFICE :—
16, GROSVENOR PLACE, S.W.1

WARNER Special PIG IRONS

- Warner C.B.R.
and
- Low Carbon Cylinder
(FOR CYLINDERS, ROLLS, ENGINEERING CASTINGS, ETC.)
- Low Carbon Malleable
(FOR MALLEABLE CASTINGS OF ALL DESCRIPTIONS)

Supplied to any specification between limits of 2·00 and 3·50% Carbon and ·50% and 3·50% Silicon

ACTUAL ANALYSIS CERTIFICATES ARE AVAILABLE WITH EACH DELIVERY

Typical Cylinder Pig Iron Specification

TOTAL CARBON	2·70%
SILICON	1·80%
MANGANESE	·90%
SULPHUR	·06%
PHOSPHORUS	·40%

Typical Malleable Pig Iron Specification

TOTAL CARBON	2·60%
SILICON	·75%
MANGANESE	·50%
SULPHUR	·05%
PHOSPHORUS	·06%

WARNER & CO. LTD
CARGO FLEET MIDDLESBROUGH

RAW MATERIALS—PRICE LIST

(Wednesday, June 16, 1937)

COPPER

	£	s.	d.
Standard cash	53	10	0
Three months	53	5	0
Electrolytic	60	0	0
Tough	61	7	6
Best selected	61	17	6
Sheets	93	2	6
India	74	2	6
Wire bars	63	2	6
Ingot bars	63	2	6
H.C. wire rods	66	12	6
Off. av. cash, May	61	4	8 1/10
Do., 3 mths., May	58	6	4 7/8
Do., Sttlmnt., May	61	3	5 1/10
Do., Electro, May	64	13	5 1/10
Do., B.S., May	65	0	0
Do., wire bars, May	65	13	1 1/10
Solid drawn tubes			14½d.
Brazed tubes			14½d.
Wire			10½d.

BRASS

Solid drawn tubes	12½d.
Brazed tubes	14½d.
Rods, drawn	11d.
Rods, extd. or rlld.	7¾d.
Sheets to 10 w.g.	10d.
Wire	9¾d.
Rolled metal	9⅞d.
Yellow metal rods	7¾d.

TIN

	£	s.	d.
Standard cash	247	15	0
Three months	247	0	0
English	248	0	0
Bars	249	15	0
Straits	249	0	0
Eastern	251	15	0
Banca (nom.)	249	5	0
Off. av. cash, May	250	16	11 13/16
Do., 3 mths., May	248	12	8 1/10
Do., Sttlmt., May	250	16	10 1/10

SPELTER

	£	s.	d.
Ordinary	20	5	0
Remelted	18	10	0
Hard	18	0	0
Electro, 99.9	22	16	3
English	21	5	0
India	17	10	0
Zinc dust	30	0	0
Zinc ashes	7	15	0
Off. aver., May	23	4	6 3/32
Aver. spot, May	23	1	10 7/16

LEAD

	£	s.	d.
Soft foreign, ppt.	21	18	9
Empire (nom.)	21	15	0
English	24	0	0
Off. aver., May	23	18	10 31/32
Aver. spot, May	24	0	0

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

Zinc sheets, English	34	10	0 to 35	0	0
Do., V.M. ex-whse.	34	10	0 to 35	0	0
Rods			28	0	0

ANTIMONY

English	82	10	0 to 83	10	0
Chinese, ex-whse.			69	0	0
Crude, c.i.f.			36	10	0

QUICKSILVER

Quicksilver	15	5	3

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—					
25%	12 10	0 to 14	0	0	(nom.)
45/50%	10 15	0 to 12	0	0	(nom.)
75%	15 15	0 to 17	0	0	(nom.)

Ferro-vanadium—
35/50% .. .. .. 12/8 lb. Va

Ferro-molybdenum—
70/75% carbon-free .. 4/9 lb. Mo.

Ferro-titanium—
20/25% carbon-free .. 9d. lb.

Ferro-phosphorus, 20/25% £21 to £22

Ferro-tungsten—
80/85% .. .. ..5/- lb. (nom.)

Tungsten metal powder—
98/99% .. .. ..5/3 lb. (nom.)

Ferro-chrome—

2/4% car.	32	17	6		
4/6% car.	22	10	0		
6/8% car.	21	10	0		
8/10% car.	21	10	0		

Ferro-chrome—

Max. 2% car.	32	10	0		
Max. 1% car.	35	15	0		
Max. 0.5% car.	36	10	0		
70% carbon-free	9½d. lb.				

Nickel—99.5/100% ..£180 to £185
"F" nickel shot £165 0 0
Ferro-cobalt, 98/99% .. 8/6 lb.

Metallic chromium—
96/98% .. .. .. 2/5 lb.

Ferro-manganese—

76/80% loose	£16	15	0 to 17	5	0
76/80% packed	£17	15	0 to 18	5	0
76/80% export			£20	0	0

Metallic manganese—
94/96% carbon-free .. 1/3 lb.
Per ton unless otherwise stated, basis 2-ton lots.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten 2s. 7d.
Finished bars, 18% tungsten 3s. 6d.
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares, 3 in. and over .. .. 4d. lb.
Rounds and squares, under ½ in. to ¼ in. .. .. 3d. lb.
Do., under ¼ in. to 3/16 in. .. 1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in. .. .. 3d. lb.
Do., under ½ in. × ¼ in. .. 1/- lb.
Bevels of approved sizes and sections .. .. 6d. lb.
Bars cut to length, 10% extra.

SCRAP

South Wales (West)—	£	s.	d.	£	s.	d.
Heavy steel, best	3	7	6 to 3	10	0	
Mixed iron and steel	3	5	0 to 3	7	6	
Heavy cast iron	3	8	0 to 3	10	0	
Good machinery			4	2	6	

Cleveland—						
Heavy steel, best	3	6	6 to 3	9	0	
Steel turnings			2	15	0	
Heavy cast iron			4	5	0	
Heavy machinery			4	10	0	

Midlands—						
Short heavy steel	3	15	0 to 4	0	0	
Light cast-iron scrap			3	5	0	
Heavy wrought iron	4	0	0 to 4	5	0	
Steel turnings	2	2	6 to 2	5	0	

Scotland—						
Heavy steel, best	3	4	6 to 3	7	0	
Ordinary cast iron			4	10	0	
Cast-iron borings	2	0	0 to 2	2	6	
Wrot-iron piling	4	10	0 to 4	12	6	
Heavy machinery			4	15	0	

London—Merchants' buying prices, delivered yard.

Copper (clean)	46	0	0
Brass	29	0	0
Lead (less usual draft)	17	0	0
Tea lead	11	0	0
Zinc	13	0	0
New aluminium cuttings	74	0	0
Braziery copper	41	0	0
Gunmetal	43	0	0
Hollow pewter	160	0	0
Shaped black pewter	115	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—

Foundry No. 1	83/6
,, No. 3	81/-
,, No. 4	80/-
Forge No. 4	80/-
Hematite No. 1	123/-*
Hematite M/Nos.	122/6*

N.W. Coast—

Hem. M/Nos. d/d Glas.	123/-*
,, d/d Birm.	134/6*
Malleable iron d/d Birm.	160/-

Midlands (d/d Birmingham dist.)—

Staffs No. 4 forge	83/-
,, No. 3 fdry.	86/-
Northants forge	80/6
,, fdry. No. 3	83/6
,, fdry. No. 1	86/6
Derbyshire forge	83/-
,, fdry. No. 3	86/-
,, fdry. No. 1	89/-

Scotland—

Foundry, No. 1, f.o.t.	115/6
,, No. 3, f.o.t.	113/-
Cleveland No. 3, Glasgow	87/-
,, ,, Falkirk	84/-
Scottish hem. M/Nos. d/d	123/-*

Sheffield (d/d district)—

Derby forge	80/6
,, fdry. No. 3	83/6
Lincs forge	80/6
,, fdry. No. 3	83/6
W.C. hematite	128/6*

Lancashire (d/d eq. Man.)—

Derby fdry. No. 3	89/-
Staffs fdry. No. 3	89/-
Northants fdry. No. 3	87/6
Cleveland fdry. No. 3	89/-
Glengarnock, No. 3	136/-
Clyde, No. 3	136/-
Monkland, No. 3	136/-
Summerlee, No. 3	136/-
Eglinton, No. 3	136/-
Gartsherrie, No. 3	136/-
Shotts, No. 3	136/-

* Subject to a rebate of 5s. per ton under certain conditions.

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumers' station for steel.

[A rebate of 15/- per ton for steel sections, plates and joists is obtainable in the home trade under certain conditions.]

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)				11	17	6
Nut and bolt iron	10	5	0 to 10	15	0	
Hoops				12	15	0
Marked bars (Staffs) f.o.t.				14	7	6
Gas strip				12	15	0

Bolts and nuts, ¾ in. × 4 in. 17 10 0 and up.

Steel—						
Plates, ship, etc.	11	8	0 to 11	10	6	
Boiler plts.	11	18	0 to 12	0	6	
Chequer plts.			13	0	6	
Angles			11	0	6	
Tees			12	0	6	
Joists			11	0	6	
Rounds and squares, 3 in. to 5½ in.			12	0	6	
Rounds under 3 in. to ¾ in. (Untested)			11	9	0	
Flats—8 in. wide and over			11	5	6	
,, under 8 in. and over 5 in.			11	10	6	
Rails, heavy			10	2	6	
Fishplates			14	2	6	
Hoops (Staffs)			12	4	0	
Black sheets, 24g. (4-t. lots)			15	15	0	
Galv. cor. shts. (,,)			19	10	0	
Galv. flat shts. (,,)			20	0	0	
Galv. fencing wire, 8g. plain			17	10	0	
Billets, soft, 100-ton lots			7	17	6	
Sheet bars			7	15	0	
Tin bars			7	15	0	

PHOSPHOR BRONZE

	Per lb. basis
Strip	13d.
Sheet to 10 w.g.	14d.
Wire	14¾d.
Rods	15d.
Tubes	20½d.
Castings	16d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
to 10g.	1/6½ to 2/1½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/5½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	25.76
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	20.38
Basic, Valley	23.50
Malleable, Valley	24.00
Grey forge, Valley	23.50
Ferro-mang. 80%, seaboard	102.50
O.-h. rails, h'y, at mill	42.50
Billets	37.00
Sheet bars	37.00
Wire rods	47.00
	Cents.
Iron bars, Chicago	2.40
Steel bars	2.45
Tank plates	2.25
Beams, etc.	2.15
Skelp, grooved steel	2.10
Steel hoops	2.40
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.80
Wire nails	2.75
Plain wire	2.90
Barbed wire, galv.	3.40
Tinplates, 100-lb box	$5.35

COKE (at ovens)

Welsh foundry	42/6
,, furnace	36/-
Durham foundry	37/6
,, furnace	35/6
Scotland foundry	34/6
,, furnace	32/6

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		24/6 to 25/6
,,	28×20 ,,		49/- to 51/-
,,	20×10 ,,		34/6 to 35/6
,,	18¾×14 ,,		24/9 to 25/9
C.W.	20×14 ,,		22/- to 23/-
,,	28×20 ,,		45/- to 46/6
,,	20×10 ,,		31/- to 32/6
,,	18¾×14 ,,		23/- to 25/-

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£12	0	0 to £13	0	0
Bars-hammered, basis	£20	0	0 to £21	0	0
Bars and nail-rods, rolled, basis	£19	0	0 to £20	0	0
Blooms	£16	0	0 to £17	0	0
Keg steel	£27	0	0 to £30	0	0
Faggot steel	£20	0	0 to £25	0	0
Bars and rods dead soft st'l	£19	0	0 to £20	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£	s.	d.		
June	10 ..	54	18	9	dec.	46/3
,,	11 ..	54	17	6	,,	1/3
,,	14 ..	54	8	9	,,	8/9
,,	15 ..	51	7	6	,,	61/3
,,	16 ..	53	10	0	inc.	42/6

Electrolytic Copper

		£	s.	d		
June	10 ..	61	0	0	dec.	20/-
,,	11 ..	61	0	0	No change	
,,	14 ..	61	0	0	,, ,,	
,,	15 ..	59	0	0	dec.	40/-
,,	16 ..	60	0	0	inc.	20/-

Standard Tin (cash)

		£	s.	d.		
June	10 ..	248	0	0	dec.	80/-
,,	11 ..	248	5	0	inc.	5/-
,,	14 ..	246	5	0	dec.	40/-
,,	15 ..	243	0	0	,,	65/-
,,	16 ..	247	15	0	inc.	95/-

Tin (English ingots)

		£	s.	d.		
June	10 ..	248	0	0	dec.	80/-
,,	11 ..	248	10	0	inc.	10/-
,,	14 ..	246	5	0	dec.	45/-
,,	15 ..	243	0	0	,,	65/-
,,	16 ..	248	0	0	inc.	100/-

Spelter (ordinary)

		£	s.	d.		
June	10 ..	20	17	6	dec.	20/-
,,	11 ..	20	17	6	No change	
,,	14 ..	20	15	0	dec.	2/6
,,	15 ..	19	0	0	,,	35/-
,,	16 ..	20	5	0	inc.	25/-

Spelter (Electro, 99.9 per cent.)

		£	s.	d.		
June	10 ..	23	10	0	dec.	20/-
,,	11 ..	23	10	0	No change	
,,	14 ..	23	7	6	dec.	2/6
,,	15 ..	21	11	3	,,	36/3
,,	16 .	22	16	3	inc.	25/-

Lead (soft foreign, prompt)

		£	s.	d.		
June	10 ..	22	2	6	dec.	15/-
,,	11 ..	22	5	0	inc.	2/6
,,	14 ..	22	1	3	dec.	3/9
,,	15 ..	21	0	0	,,	21/3
,,	16 ..	21	18	9	inc.	18/9

Lead (English)

		£	s.	d.		
June	10 ..	24	5	0	dec.	15/-
,,	11 ..	24	5	0	No change	
,,	14 ..	24	5	0	,, ,,	
,,	15 ..	23	0	0	dec.	25/-
,,	16 ..	24	0	0	inc.	20/-

AVERAGE MONTHLY PRICES OF CLEVELAND No. 3 PIG-IRON.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1897	41 2	40 4	40 5	39 2	39 7	40 9	39 6	40 5	41 7	42 5	41 5	40 4	40 7
1898	40 9	40 8	40 6	40 0	40 7	39 11	40 4	41 11	43 0	44 11	49 1	44 3	42 0
1899	46 10	47 11	47 9	49 10	55 11	62 10	71 6	65 9	67 7	68 8	70 0	66 9	60 5
1900	67 10	68 10	73 10	76 2	74 2	68 6	69 3	71 4	70 9	67 8	63 6	53 6	68 9
1901	48 0	46 6	45 8	45 5	45 10	44 7	44 6	45 3	45 3	45 3	43 6	43 1	45 3
1902	43 11	46 7	46 9	47 11	48 10	49 7	50 9	52 1	53 6	52 9	50 9	47 11	49 3
1903	47 3	48 9	51 10	49 0	46 1	46 2	46 7	46 8	45 7	43 6	42 10	41 11	46 4
1904	42 3	42 7	43 3	44 7	44 0	42 10	42 9	43 3	43 1	43 9	46 1	48 7	45 11
1905	48 11	48 0	49 6	50 1	51 5	45 6	45 9	47 5	48 8	52 11	52 9	53 3	49 6
1906	53 9	50 1	48 1	48 8	50 2	50 3	50 6	53 0	54 6	56 8	58 6	62 4	53 6
1907	60 4	56 6	54 10	56 0	61 1	58 1	57 8	57 8	55 7	54 8	50 8	50 0	56 2
1908	48 5	49 3	51 7	51 10	51 6	51 2	50 0	51 4	52 0	49 8	49 4	48 11	50 8
1909	48 10	48 1	46 9	47 9	48 4	48 9	48 6	50 5	51 3	51 11	51 2	50 7	49 4
1910	51 10	51 3½	51 7½	50 10	49 10	49 2	48 10	49 8½	49 3½	49 7½	49 6½	49 10	50 4
1911	49 11½	49 2½	48 5	46 11	46 4	46 6	46 11½	47 4	47 0	46 7	47 4½	48 1	47 7
1912	50 0	49 5½	51 1½	53 7½	54 4	55 1	57 5½	64 6½	61 7½	66 8½	67 8	68 0	58 8½
1913	66 11½	63 8½	64 8	67 1½	66 3	56 9½	56 3½	55 8	55 4	53 0	50 1	50 4	58 10
1914	50 11	51 5½	51 0½	51 4½	51 6	51 6½	51 5	52 3	51 5	50 1	50 3	53 0	51 4½
1915	55 7	56 6	61 0	66 7	65 2	66 10	65 4	66 0½	65 3	65 11	69 10½	75 7½	64 7
1916	80 2	91 6	87 4½	86 10	82 6	82 6	87 6	87 6	87 6	87 6	87 6	87 6	86 10
1917	87 6	87 6	87 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	95 0	99 3
1918	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0
1919	95 0	95 0	95 0	95 0	152 6	160 0	160 0	160 0	160 0	160 0	160 0	160 0	137 8
1920	175 0	175 0	187 6	200 0	208 0	217 6	217 6	221 0	225 0	225 0	225 0	225 0	209 3
1921	222 6	195 0	150 0	126 0	120 0	120 0	120 0	136 3	127 0	120 0	110 0	100 0	137 4
1922	92 6	90 0	90 0	90 0	90 0	90 0	89 0	87 3	92 6	92 6	92 6	91 3½	90 7½
1923	94 6	108 9	125 6	129 4½	128 5	136 0	128 1½	121 11	97 1½	97 0	100 0	100 0	110 6½
1924	99 10	97 3½	91 9	93 9	91 9	89 10½	87 9	85 0	82 5½	80 2½	81 9	81 9	88 7½
1925	80 4½	78 10½	78 0	78 3	76 0	73 10½	71 7½	69 10½	68 1½	66 7½	66 0	66 10½	72 10½
1926	69 4½	70 0	70 0	70 0	72 6	75 10½	86 7½	90 0	93 10½	117 10	120 0	99 0	86 3
1927	85 0	83 1½	81 0	80 0	73 9	70 0	70 0	68 9	67 8	67 6	66 10½	65 0	73 2½
1928	65 0	65 0	65 6	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	65 9½
1929	66 0	66 9	67 0	68 1½	69 5	71 10½	72 9	72 6	72 6	72 6	72 6	72 6	70 4½
1930	72 6	72 6	70 0	67 6	67 6	67 6	67 6	64 6	63 6	63 6	63 6	63 6	66 11½
1931	59 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 7
1932	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6
1933*	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6	62 6
1934*	62 6	65 0	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	66 10½
1935*	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	67 6	69 4½	70 0	67 10½
1936*	70 0	70 0	70 0	70 0	70 0	70 0	75 0	75 0	75 0	75 0	75 0	81 0	73 0
1937*	81 0	81 0	81 0	81 0	81 0	81 0	—	—	—	—	—	—	—

* Delivered Middlesbrough area. Prior to 1933, prices were f.o.t. furnaces.

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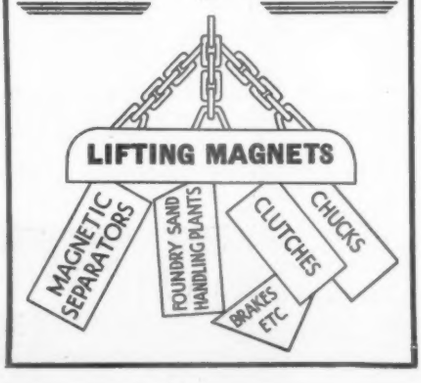
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